MACHINERY

JULY, 1914

MANUFACTURE OF SAVAGE 0.22 CALIBER HIGH-POWER RIFLE*—1

EFFECTIVENESS OF A HIGH-POWER SMALL CALIBER RIFLE—MANUFACTURING AND TESTING METHODS AT THE FACTORY OF THE SAVAGE ARMS CO.

BY FRANKLIN D. JONES†

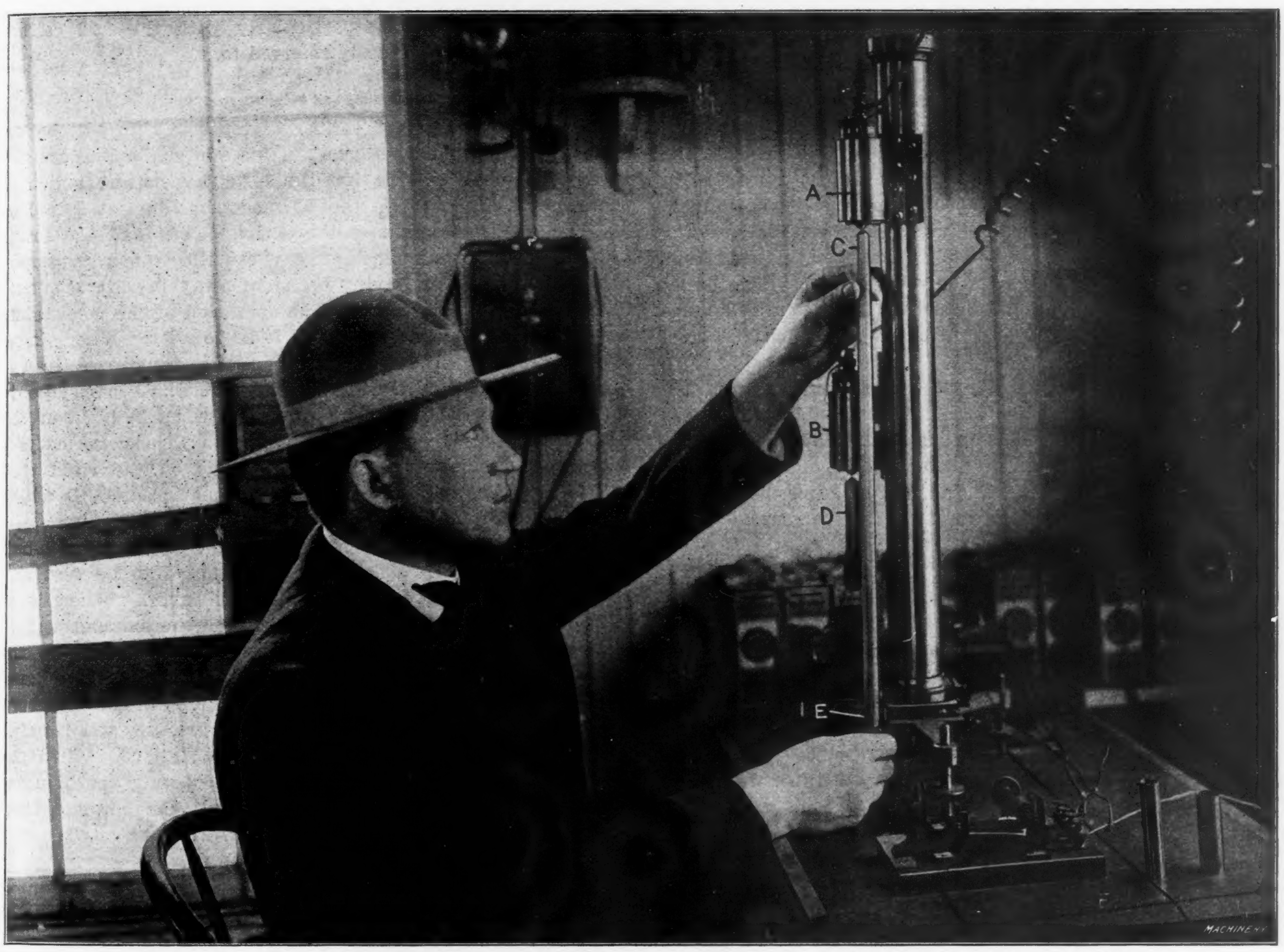


Fig. 1. The Chronograph, used to determine the Initial or Muzzle Velocity of a Rifle Bullet—The Instrument is being adjusted preparatory to making a Test

NOT many years ago the average sportsman prided himself on owning a rifle of large caliber, the idea being that a bullet must be large to be deadly. Modern gunmakers, however, have demonstrated that a small bullet may be much more effective and destructive than a large one, if it has the power behind it and is correctly shaped so that the average velocity during flight will be as high as possible, thus flattening the trajectory and increasing the accuracy as well as the striking energy of the bullet. The result has been that large calibers have been quite generally superseded by smaller ones, such as the 30-30 and other comparatively small bores, as those interested in firearms know.

One of the most wonderful developments of the small caliber high-power rifle has been made by the Savage Arms Co. of Utica, N. Y. We refer to the 0.22 caliber high-power rifle placed on the market by this company about a year ago. In many respects, this is the most remarkable firearm ever designed and manufactured, owing to the inverse relation between the size of the bullet and its destructive power. It is a hammerless repeater and is similar to the '99 model so far as the action is concerned. This rifle was originally intended for shooting wolves, coyotes, foxes, etc., but actual hunting experience has shown it to be powerful enough for deer, moose, caribou, mountain sheep, and even for such large game as Alaskan brown bear and American black bear.

Here are some figures which will show, in a general way, the performance of this rifle. The initial or muzzle velocity is 2800 feet per second and the theoretical striking energy over 1200 foot-pounds. The velocity is higher than that of any other firearm manufactured in this country and is 100 feet per second higher than that of the new Springfield United States Army rifle. Owing to this extreme velocity, the trajectory (or path followed by the bullet in its flight) is very flat, which increases the accuracy, especially at long ranges. The mid-range height of the trajectory for a range of 200 yards is only 2.99 inches and the rifle can be used for distances up to 350 yards without changing the point-blank adjustment of the sights. Under favorable weather conditions, this rifle (which only weighs 6¼ pounds) has done excellent work on a military target at 1000 yards range. It has scored twenty-five consecutive "bulls" on the 500-yard military target (20-inch bullseye), and has placed ten consecutive shots within a 10-inch circle at 500 yards. To those familiar with rifle shooting, these figures speak for themselves.

* For information on rifle manufacture previously published in MACHINERY see the series on "The Ross Rifle and Its Manufacture" in the October, November and December, 1911, and January, 1912, numbers of MACHINERY. See also articles referred to in connection with the first installment.

† Associate Editor of MACHINERY.

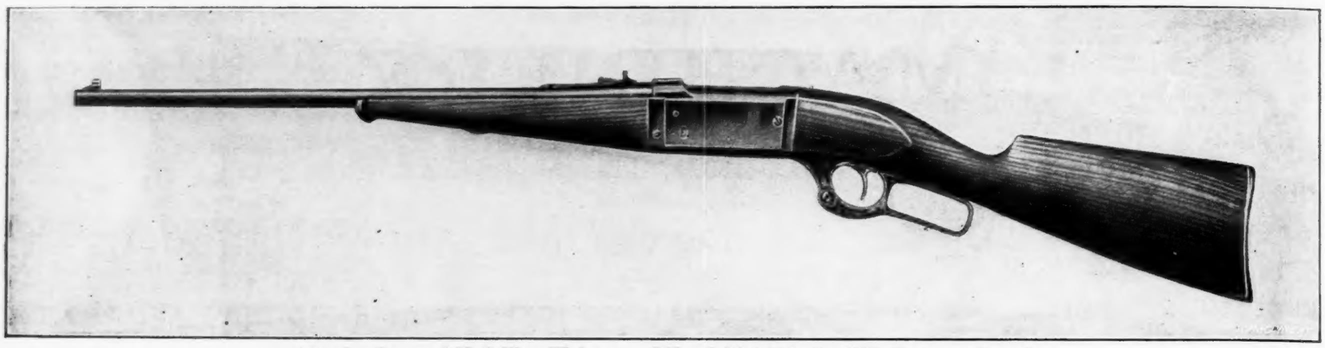


Fig. 2. Savage 0.22 Caliber High-power Rifle—Initial Velocity 2800 Feet per Second

The following data may also be of interest: The weight of the bullet is 70 grains; the diameter of the bullet, 0.228 inch; the diameter of the barrel from groove to groove, 0.2275 inch; the number of grooves, six; the lead of the rifling or the distance the bullet travels to complete one revolution, 12 inches. The pressure back of the bullet at the instant of discharge is 48,000 pounds per square inch. Incidentally, the pressure in a 14-inch gun, which is the largest now used in the United States Navy, is 35,000 pounds per square inch. These comparative figures are interesting, especially when we consider that the rifle can safely withstand this enormous pressure, although its weight is only 6¼ pounds. The bullet will penetrate a pine block in an endwise direction a distance of 7¾ inches, and it will pass through ½-inch chilled steel boiler plate.

The performance of this rifle at ranges varying from 100 to 1000 yards is given in the accompanying table, which was compiled by the ballistic department of the Savage Arms Co. The first horizontal column gives the ranges, and the second, the velocity in feet per second. As will be seen, the velocity at a distance of 700 yards is over 1000 feet per second. The mid-range trajectory or the vertical height of the path described by the bullet at a point midway between the rifle and target varies from 0.506 inch at a range of 100 yards to 248.5 inches at 1000 yards. The angle of departure represents the angle at which the rifle barrel must be elevated for a given range, to cause the bullet to strike at a point in the same horizontal plane as the muzzle of the rifle. By referring to the table, it will be seen that for 100 yards this angle is only 2 minutes 5 seconds, and for a long range of 500 yards, it is only 18 minutes 32 seconds, or less than one-third degree.

At the plant of the Savage Arms Co. new rifles are designed in the ballistic and experimental department. To develop a high-grade firearm not only requires a thorough knowledge of ballistics but a broad mechanical knowledge as well, in order to obtain a design that is not only accurate and effective, but mechanically perfect so that it can be manufactured on an economical basis. The designer begins with the cartridge and largely builds the rifle around it. He is confronted with many problems, all of which must be considered—and the problems are not solved in a day, but as the result of numerous experiments backed up by wide experience. The rifle designer has an interesting but difficult task; in fact, so difficult that no intelligent conception of the methods of procedure could be given here even though we were familiar with this science. So we shall leave the ballistic department and consider some of the methods and tools employed by the Savage Arms Co. in the manufacture of rifles, dealing particularly with the 0.22 caliber high-power design previously referred to.

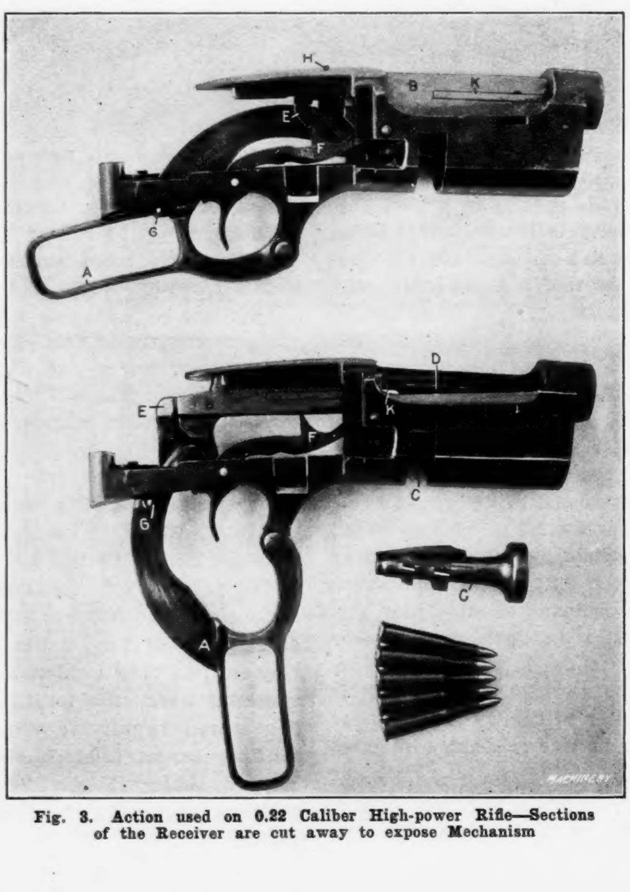


Fig. 3. Action used on 0.22 Caliber High-power Rifle—Sections of the Receiver are cut away to expose Mechanism

Action of the Savage High-power Rifle

The action of the 0.22 caliber high-power rifle will be described first so that references in this and succeeding articles to specific parts will be intelligible. This action, which is the same as that used in the '99 model, is illustrated in Fig. 3. The upper view shows the action closed and the lower view shows it open. These two views illustrate a "cut-open action," the receiver having been cut away in several places to expose the interior parts. The operation of the mechanism for loading, firing, and reloading is as follows: When finger lever *A* is thrown down to the position illustrated in the lower view, it withdraws the breech-bolt *B*. A cartridge in the rotary magazine carrier *C* then jumps up in front of the breech-bolt and is held in position by a three-point contact between the carrier, the cartridge guide on the right side of the receiver, and the ejector or automatic cut-off *D* which is now forced out over the cartridge by a spring.

As lever *A* is pulled back to close the action, breech-bolt *B* moves forward, pressing ejector *D* back into its seat and pushing the cartridge forward into the barrel. When lever *A* is pulled back about half way, lug *E* on the hammer strikes against the sear *F* and the hammer is held back. As the forward movement of the breech-bolt is continued, the hammer spring is compressed, and when the breech-bolt is forced upward to its seat, the rifle is ready to fire, the action being in the position shown by the upper view, Fig. 3. When the trigger is pulled it turns sear *F* downward until the hammer is released; the hammer then flies forward and strikes the firing pin.

When lever *A* is again pushed forward, the extractor *K* (which is a latch shaped part at the end of the breech-bolt that hooks over the rim of the cartridge) withdraws the cartridge shell from the barrel. When the shell is back far enough to clear the forward end of the receiver, it strikes a small projection on the ejector *D* and is whirled around and out of the receiver. As the shell is thrown out, the ejector moves out over the next cartridge which is now in front of the bolt and in position for loading. The cycle of movements just described is repeated each time the rifle is fired.

The entire mechanism is very simple and positive in its movements. When the action is closed, the breech-bolt is forced upward to its seat by a cam surface on the inner end of lever *A*. The lower side of this inner end also bears on a

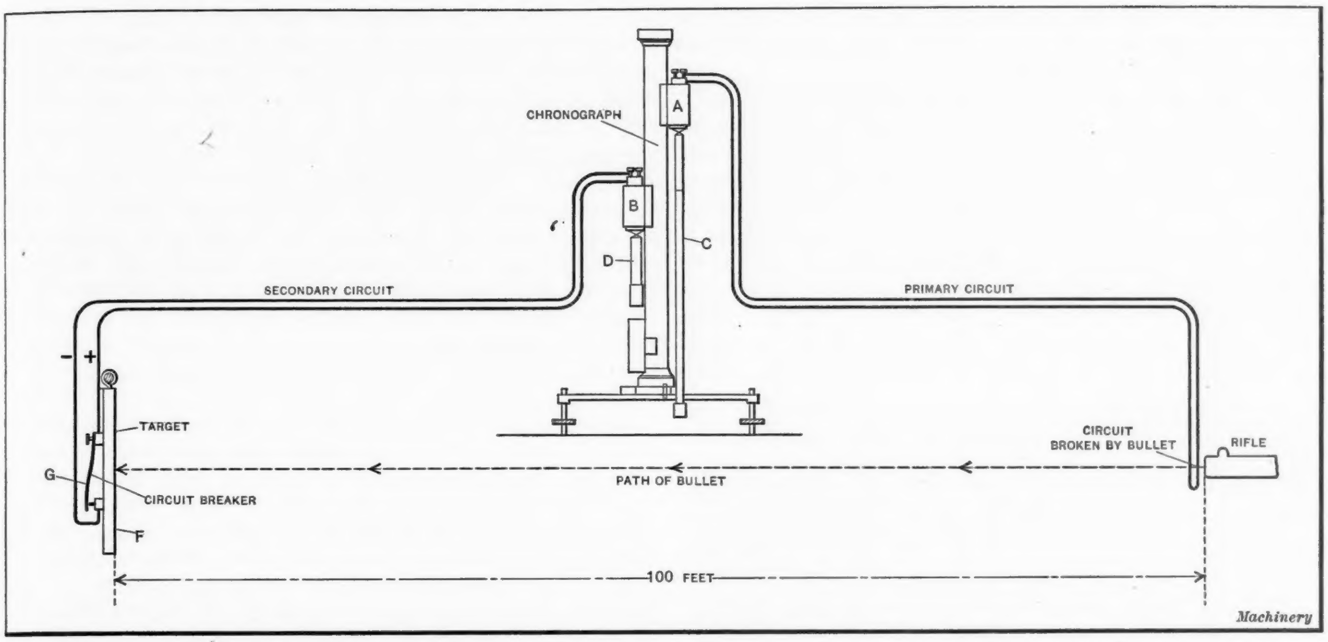


Fig. 4. Diagram showing how Primary and Secondary Circuits of the Chronograph are broken at Muzzle of Rifle and at Target by Bullet

projection on the bottom of the receiver, so that the breech-bolt is not only supported by the solid receiver frame at the rear, but has a positive support against downward thrust as well. In designing this action, particular attention was given to the matter of safety. By pushing the small slide *G* forward, the lever as well as the trigger is positively locked to prevent accidental discharge. The position of the hammer, that is whether cocked or uncocked, is shown by a small pin *H* which projects when the hammer is cocked.

As previously mentioned, the cartridges, when in the rifle, lie side by side around the circular, revolvable magazine carrier *C*. This arrangement prevents the bullet of one cartridge from bearing against the primer of another, thus making it impossible to discharge a cartridge while in the magazine by endwise shock. The forward end of the magazine carrier is in the form of a circular disk (see detail view) and is numbered from 0 to 5. These numbers are visible through a small aperture on the left side of the receiver and show the number of cartridges in the magazine.

General Process of Manufacture and Factory System

In this particular article, the manufacturing operations, as well as the inspection system, will be referred to in a general way, the idea being to present specific operations of interest in succeeding articles where the space will permit of detailed descriptions. Rifle manufacture is quite different from other lines of manufacture involving the use of metal-working tools. This is partly due to the irregular and intricate shapes of many of the parts, which makes it necessary to use many special tools and fixtures. The irregular shapes which must be machined, often with a considerable degree of accuracy, also greatly increase the number of operations required. For example, a receiver for the action illustrated in Fig. 3 requires 128 separate operations and the finger lever, 51. Most of these are machining operations. While in some cases there is a great deal of work on one part, this part is carefully designed to serve many purposes in a simple way.

The manufacturing operations may be divided into the following general classes: Turning, drilling, reaming and rifling the barrel; machining the receiver and its attached parts which form the action or breech mechanism; turning, inletting and mortising the stock; polishing and finishing the various parts; assembling; inspecting. The inspection is referred to last, but this does not mean that there is but one final inspection. In fact, this system has been very carefully developed and will be explained later.

The barrel is made from alloy steel of special composition and of the same analysis as the steel used in the barrels of the new Springfield United States Army rifle. After the outside is rough-turned close to the finished size, the hole is drilled. The drilling, reaming and rifling is done in the well-known Pratt & Whitney machines which will be described in the second installment of this series. The work on the breech mechanism is done largely on Lincoln type milling machines or "power mills," profiling machines, hand milling machines, and drilling machines. Multiple-spindle, semi-automatic, combination drilling, reaming, and milling machines of special design are also used for machining the receivers. While many of the operations on the different rifle parts are common to those familiar with manufacturing methods, the Savage factory contains a great variety of special tools and fixtures, many of which are very ingenious and enable the work to

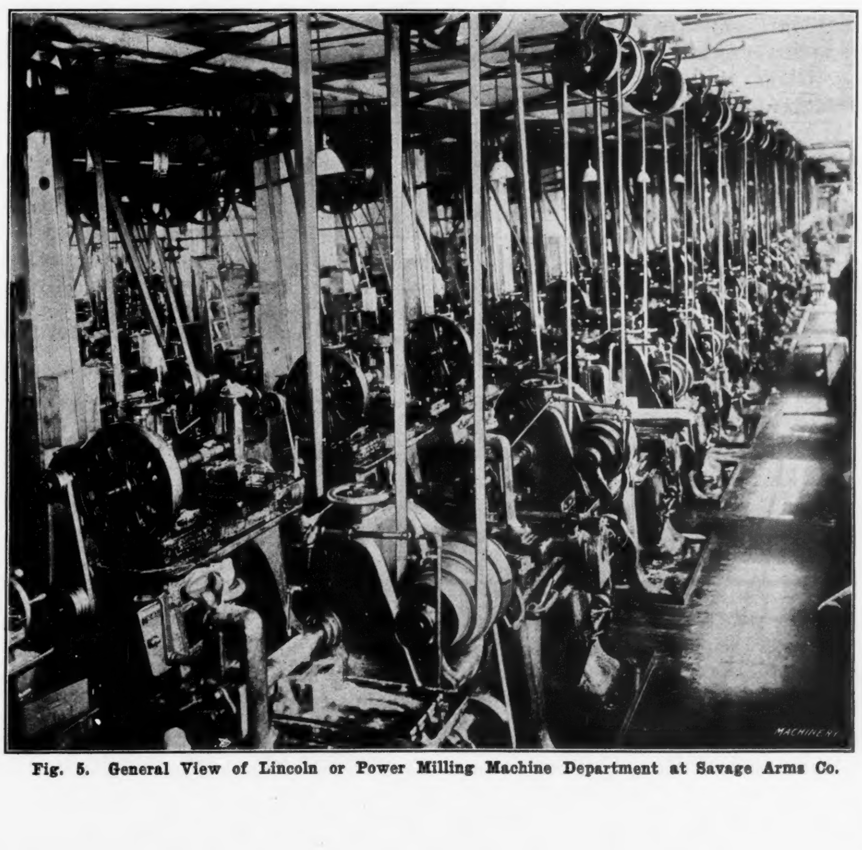
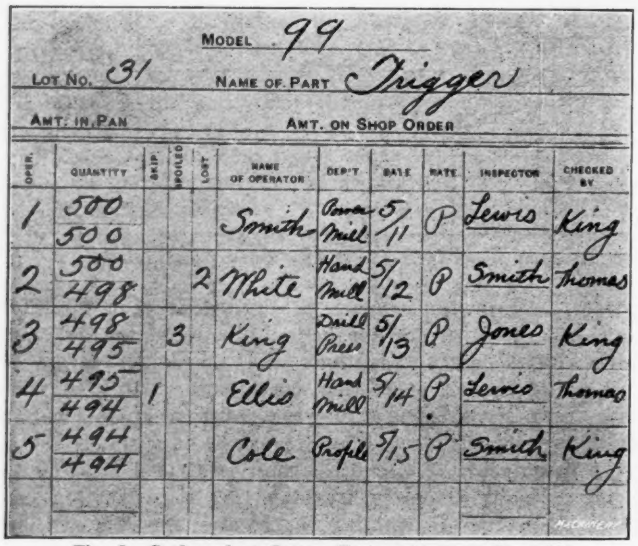


Fig. 5. General View of Lincoln or Power Milling Machine Department at Savage Arms Co.

be done rapidly and accurately. Some of the small parts of the action, especially for the lighter class of rifles, are blanked out and formed in dies.

Many thousands of parts are being machined continually in the factory of the Savage Arms Co., and in order to account for these parts without confusion and excessive waste of time, a very simple but effective system has been adopted which is utilized by the cost, inspection and manufacturing departments. The most important feature of this system is a card, such as the sample shown in Fig. 6, which accompanies each lot of parts that is to be machined and makes it possible to determine quickly the exact quantity of completed parts that is in stock. This card also serves other important purposes in connection with inspection, etc. When


MODEL 99
LOT NO. 31 NAME OF PART Trigger
AMT. IN PAN AMT. ON SHOP ORDER

OPER.	QUANTITY	SKIP	SPOILED	LOST	NAME OF OPERATOR	DEP'T	DATE	RATE	INSPECTOR	CHECKED BY
1	500 500				Smith	Power Mill	5/11	P	Lewis	King
2	500 498			2	White	Hand Mill	5/12	P	Smith	Thomas
3	498 495		3		King	Drill Press	5/13	P	Jones	King
4	495 494	1			Ellis	Hand Mill	5/14	P	Lewis	Thomas
5	494 494				Cole	Profile	5/15	P	Smith	King

Fig. 6. Card used at Savage Factory in connection with Manufacturing and Inspection Systems

a certain lot of parts is to be machined the tray containing them is accompanied by one of these cards. As will be seen, it gives the model of the rifle, the name of the part and the lot number. All operations are numbered, and the vertical column to the left contains the operation numbers for this particular part. In the next column is recorded the number of parts which are sent to each operator and also the number of good parts he returns. In this particular case, the card shows that 500 parts were sent out for the first operation and 500 were returned. For the second operation, 500 parts were sent out but only 498 were returned, two being lost; hence 498 are credited on the card and the operator is paid for the actual number returned. On the third operation three parts were spoiled and did not pass the inspector so that the number is now reduced to 495, and the final number after the fifth operation is 494, because, in this case, one part was "skipped" and came to the inspection department without being machined. When all the operations are finished and the parts are found to be up to the required standard of accuracy, the final number of completed parts, as shown by the card, is transferred to a card index so that the quantity on hand can be determined at any time. The card also gives the name of the operator, the department in which the work was done, the date upon which each operation was completed, the rate of pay for each operator, and the names of the inspectors.

System of Inspection

Each machine department has one or two inspectors who make frequent inspections while the work is being done, so that in case a machine is out of adjustment slightly or a cutter has worn excessively, the error will be detected before a large quantity of work is finished. From this it will be seen that the inspection is not only to detect inaccuracies but to prevent them. For instance, if the "outside" or department inspector finds that the cutter of a profiler is a little too high, the parts which were milled while the cutter spindle was incorrectly adjusted are run through again. These outside inspectors are constantly on the lookout for trouble and greatly reduce the number of parts rejected by the final inspection which is made in a centrally located inspection department.

The method of handling the various parts, while they are being transferred from one department to another, is worthy of note. Small pieces, such as triggers, sears, hammers, etc., are kept in plain metal trays, and the larger parts, such as rifle receivers or pistol frames, are placed in special trays in an orderly, convenient way. A number of these trays may be seen in the illustration Fig. 1. When the parts in one tray have been machined and are returned to the inspection department, another tray of rough parts is ready, so that there is no delay.

In addition to the careful inspection of the individual parts during the process of manufacture, the action of the rifle is thoroughly tested in the assembling department, and, finally, the operation and accuracy of the rifle by actual use. In connection with this final test, which is made by expert marksmen, the sights are carefully adjusted.

Determining Initial Velocity of Bullet with Chronograph

One of the most interesting instruments used in connection with rifle testing is the chronograph. By means of this instrument, which is illustrated in Fig. 1, the initial or muzzle velocity of a bullet is determined. The chronograph has two magnets, *A* and *B*, which have sufficient power to hold the bars *C* and *D* when the circuits are closed. Magnet *A* is fixed to the vertical column of the chronograph, whereas magnet *B* is adjustable vertically. (The purpose of this vertical adjustment will be referred to later.) Magnet *A* is energized by a primary circuit, and magnet *B* by a secondary circuit. The primary wire crosses the muzzle of the rifle and the secondary circuit connects with the target. When the rifle is fired the bullet cuts the primary circuit and the long bar *C* drops. Now when the bullet hits the target, which is located 100 feet from the rifle, the secondary circuit is momentarily broken, thus demagnetizing magnet *B*. The short bar *D* then drops and falls through a tube located just beneath it and onto a trip which releases a spring-actuated marking plunger at *E*, which is forced outward and instantaneously makes a mark on the long bar *C* as it drops. The distance from this mark to a standard datum line on bar *C* indicates the initial velocity of the bullet. That this dis-

PERFORMANCE OF SAVAGE 0.22 CALIBER HIGH-POWER RIFLE

Ballistic coefficient, 0.25 Weight of bullet, 70 grains

	Range in Yards										
	Muzzle	100	200	300	400	500	600	700	800	900	1000
Velocity, Ft. per Second	2800	2345	2103	1803	1542	1320	1152	1044	967	905	851
Mid-range Trajectory, Inches	......	0.506	2.998	7.325	15.289	28.515	48.037	77.502	120.787	172.51	248.576
Angle of Departure	......	2′ 5″	5′ 13″	8′ 36″	12′ 58″	18′ 32″	25′ 13″	33′ 44″	43′ 48″	55′ 48″	1° 10′ 42″
Time of Flight, Seconds	......	0.113	0.248	0.402	0.583	0.794	1.041	1.316	1.615	1.939	2.280
Energy in Foot-pounds	1218	922	688	505	370	271	206	170	145	127	113

Machinery

tance will enable the velocity to be determined will be more apparent when we consider the fact that if both circuits were broken at the same instant, the mark made on bar *C* as it fell would exactly coincide with the datum line, provided magnet *B* were adjusted to the proper vertical height; but there is an interval between the breaking of the circuits which is equal to the time required for the bullet to travel from the rifle to the target, or 100 feet. Therefore, when the primary circuit is first broken by the bullet as it leaves the rifle, bar *C* begins to fall and when the secondary circuit is broken by the bullet as it hits the target, the mark made on bar *C* does not coincide with the datum line but is some distance from it, this distance determining the velocity of the bullet. The velocity is ascertained by measuring the distance between the lines with a special instrument which resembles an ordinary vernier caliper, except that it is longer and is graduated to give direct velocity readings in feet per second.

Before using the chronograph it must be "leveled," which means that the adjustable magnet *B* for holding the short bar must be moved vertically until the marker strikes the long bar exactly on the datum line when both primary and secondary circuits are broken at the same instant. The distance from the marker to the datum line on the bar is standard and if the instrument is properly adjusted, the marker should strike this line when both magnetic circuits are broken at the same time. The point, however, at which the mark is made when the circuits are broken simultaneously varies with the altitude and also because of different atmospheric conditions; hence, it is necessary to make this vertical adjustment of magnet *B* each time the chronograph is used, and on some days considerable time is required to get the adjustment exactly right. The holding power of the magnets must also be within certain standard limits. The energizing current is regulated by a rheostat until the magnet will hold the bar but will not hold it when a standard auxiliary weight is attached. These weights are in the form of tubes which are placed over the bars and are supported by shoulders at the lower end. The tubes are shown in the lower right-hand corner of Fig. 1. The method of breaking the circuit at the target the instant the bullet strikes is very simple but ingenious. The diagram Fig. 4 illustrates the principle. When the bullet strikes the steel target plate *F*, the impact causes the thin, flat spring *G* to jump off the binding post which momentarily breaks the secondary circuit and causes the short bar of the chronograph to fall and release the marker, as previously described. This diagram also shows how the primary circuit is broken by the bullet as it leaves the rifle. Of course it will be understood that the position of the chronograph relative to the rifle and target is immaterial.

In the next installment of this article some interesting machining operations on various rifle parts will be described in detail.

* * *

The following story is told about the early experiences of one of the leading men in the machine tool building field in America today. Some twenty-five years ago, when he arrived in the United States from across the sea, his knowledge of the English language was not all that might have been desired, and when he was first employed in a railway shop the foreman, for that reason, proportioned his compensation accordingly. This man, however, was a good mechanic and he soon satisfied himself that he was giving as much in return for his small wage as the native journeymen. He therefore promptly applied to the foreman for a raise, which was refused with the explanation that as the young man could not talk English very well, it was not possible to pay him any more. This explanation was quite unsatisfactory to the applicant, who quickly replied: "——— ——— it, I want to know whether you are keeping me here to talk or to work." He got the raise.

* * *

A light weight metal alloy known as "metal cork," considered superior to aluminum, is made from about 90 per cent magnesium, the remainder being zinc, sodium, aluminum and iron. The specific gravity of this alloy is said to be 1.76.

THE SYSTEMATIZER AND HIS SYSTEM

Perkins was an efficiency expert and systematizer. He had equipped the offices with innumerable card systems and blanks and report forms, and to save work and time in the writing and reading of long and cumbersome names, the men in the shop were all numbered. He installed various accounting machines and also a Hollerith tabulating machine, such as is used by the census office.

He was also a worker, and so it happened that one Thanksgiving day, in the afternoon, when everybody else was digesting turkey, he went down to the shop to plan some more systems and devise a few more blanks to be filled out when a stripped ⅜-inch nut had to be replaced with a new one on the machine known as "B-No. 36." It happened that a little later in the afternoon he found that he wanted to run the tabulating machine, but as the engine in the shop was not running and as he did not know that there was an emergency connection with the city supply, he was at a loss how to get current for the ¼-horsepower motor of the machine; but as a great systematizer is never at a loss for long, he wandered down into the engine room, only to find that the engineer was properly celebrating Thanksgiving with his family, as every engineer ought to be given a chance to do. In the boiler room, however, he found a fireman, and he promptly ordered him to start the 200-horsepower high-speed engine that was direct-connected to the dynamo, in order that current might be produced for the ¼-horsepower motor upstairs. The fireman, however, knew nothing about engines, nor about dynamos, and what is more—he knew that he did not know anything about them, and he said so. The systematizer went upstairs again and thought the matter over, and the more he thought about it the more thoroughly it was impressed on his mind that a fireman was inefficient if he did not know how to run an engine in an emergency case, and he went down again and told the fireman that it was up to him to start that engine or lose his job. Now, the fireman was used to doing the firing himself, and being fired by somebody else did not appeal to him, particularly as he had a wife and children depending upon him; so he took a chance, and after he had tried a number of handwheels on various valves, he got the big engine started.

Then there was another difficulty—the fireman did not know which switch to throw to connect with the ¼-horsepower motor upstairs. The efficiency expert, however, quickly found a way out of this difficulty. He told the fireman to throw in one switch at a time, he himself, in the meanwhile, being upstairs to note the effect. When the fireman threw the proper switch, the motor would start, and he would then signal over the telephone.

So after all the ¼-horsepower motor was running fine and cards passed through the tabulating machine at high speed, and the systematizer was delighted to add to his collections a few hundred more cards; but in about fifteen or twenty minutes the motor began to slow down, and then it stopped suddenly. The scientific systematizer rose in wrath; the fireman was playing a trick on him and had turned off the power. In about three jumps he found himself downstairs in front of a frightened fireman protesting his innocence, and then they both entered the engine room. To a great systematizer the sight was probably not so horrible, but we hate to think of the words that the engineer used when, disturbed by a hurry-up call in his Thanksgiving celebration, he came in and saw it. The engine had been running without oil—there being no card index indicating how often the engine should be oiled—and the babbitted main bearing next to the flywheel had become overheated. More than that, it had become so excessively overheated that it had partly melted away, and the flywheel was tipped at an angle as if it, too, had been celebrating Thanksgiving in an improper manner. At the other end, the rotor of the dynamo was dislocated and the armature had scraped against the pole pieces.

Just how much it cost to repair the damage is recorded only in the card index of the scientific systematizer, and what the general manager said to him the next morning, when the full details of the matter had been established, is not recorded anywhere.

CHUCKING METHODS FOR IRREGULAR PARTS*

FIXTURES FOR HOLDING UNUSUAL LATHE AND BORING MILL WORK

BY ALBERT A. DOWD†

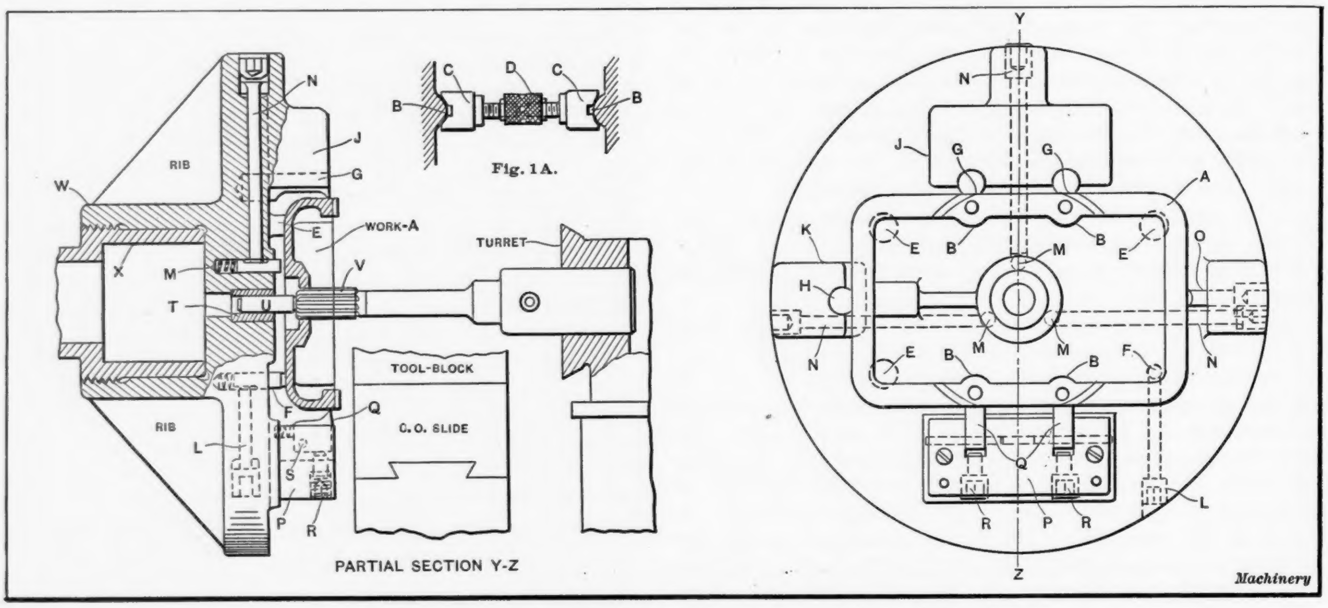


Fig. 1. Chuck for Rectangular Aluminum Castings used on Horizontal Turret Lathe

CASTINGS or forgings of irregular form usually require some method of holding (for the purpose of machining) other than chuck jaws, although there are many instances when the latter can be used to advantage. The form and size of the work have a great influence on the method of handling, and the accuracy required is also an important factor. The work itself may be in the rough state without any machining previous to the chucking operation or it may have been milled, planed or drilled. In the former case it is necessary to design a method of holding suited to the rough piece, and care must be exercised in selecting the surfaces best adapted for locating the work. It may even be necessary to have additional lugs or bosses cast or forged on the piece in order to facilitate holding it in position on the fixture. If walls are thin care must be used also in the method of clamping so that no distortion will take place. In case a previous operation of milling or planing has taken place, it is essential that the fixture be so designed that this surface be used for locating in order that accurate work may be assured. There are occasional instances when both milling and drilling operations have preceded the chucking. This may possibly complicate matters somewhat or it may simplify them depending on the conditions. Sometimes a series of holes has been drilled in a flange which has been surface milled, and in a case of this sort the holes may prove useful for clamping purposes. When a case is encountered with a milled surface and an angular hole, or some other condition of a similar nature, there may be more difficulty in designing the fixture.

The type of machine upon which the work is to be accomplished is also a factor which largely influences the design, and this matter should be decided positively before any attempt is made to draw up the device. The types of machines for which fixtures of this sort are most frequently designed

* For further information on the subject of work-holding devices and kindred subjects, see MACHINERY, October, 1913, "Work-holding Arbors and Methods for Turning Operations," and "Arbors for Second-operation Work"; November, 1913, "Holding Devices for First-operation Work"; June, 1914, "External Holding Devices for Second-operation Work." See also MACHINERY'S Reference Book No. 120, "Arbors and Work-holding Devices."

† Address: 84 Washington Terrace, Bridgeport, Conn.

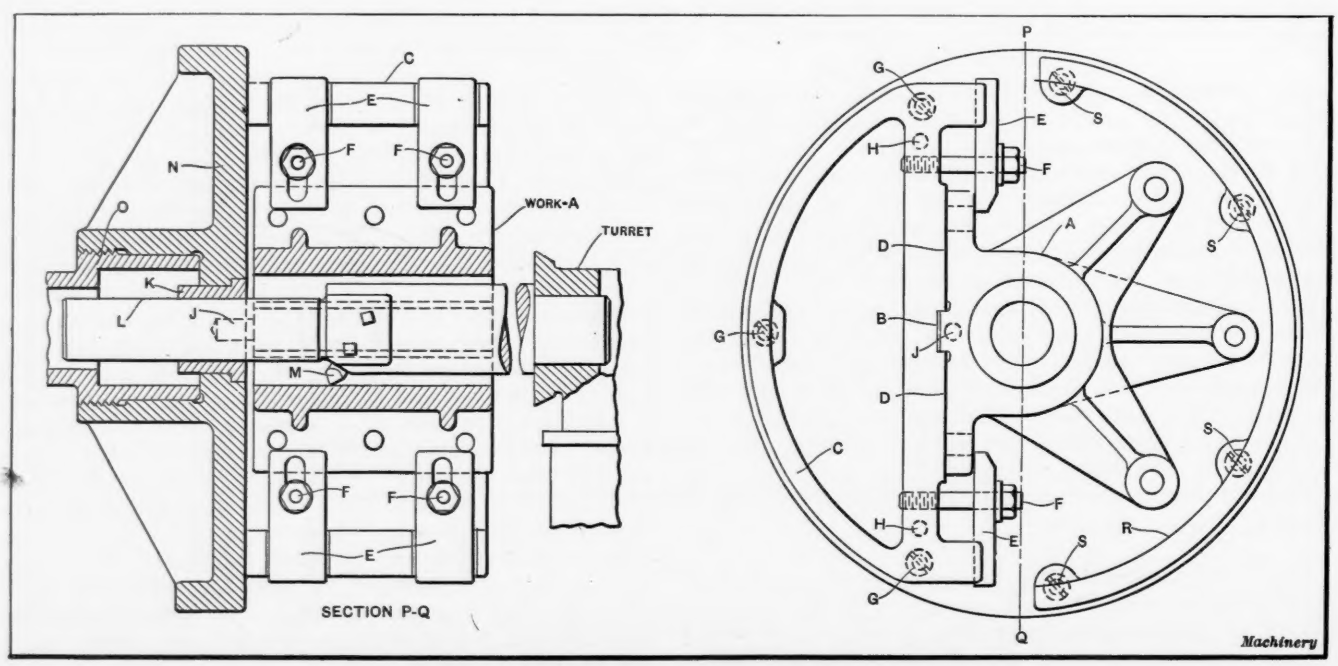


Fig. 2. Fixture for boring Irregular Castings on Horizontal Turret Lathe

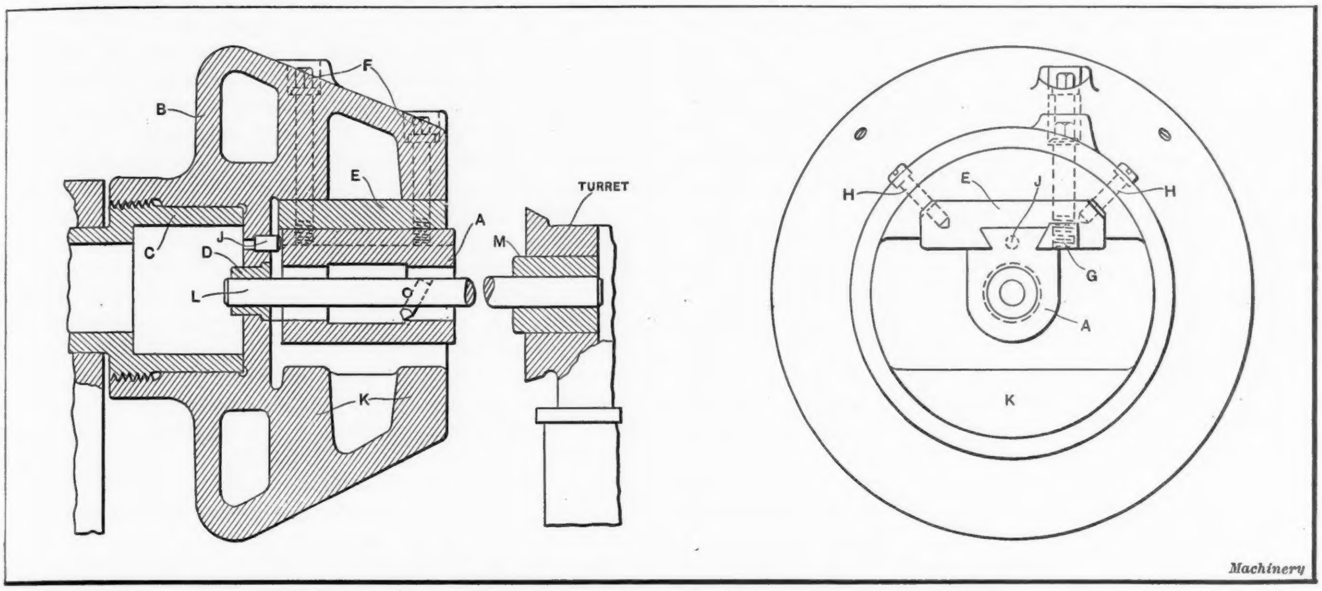


Fig. 3. Fixture for boring Small Bronze Castings on Horizontal Turret Lathe

are the horizontal and vertical turret lathes and the vertical boring mill. The engine lathe is also occasionally fitted with an arrangement for this kind of work, but as the construction of the fixtures is very similar to those used on the horizontal turret lathe it is not necessary to differentiate between the two in this article.

It is obviously out of the question to attempt to cover or describe all the conditions which may be encountered in the chucking of irregular work, but the examples here given represent a variety such as may prove of considerable value in elementary design. Adaptations to suit various conditions will suggest themselves to the progressive designer. Attention is called to a few of the important points in the design of fixtures of this character.

Important Points in Design

1.—*Locating points or surfaces.* These are very important and should be selected with care, having in mind any ribs, lugs or raised lettering on the casting, so that no trouble can be caused through faulty locating. Make use of the vee principle when the shape of the work will permit it. If four points are needed in the same plane for proper support or location of a rough surface, be sure that one of these points is movable to compensate for inequalities in the surface. If a finished surface is to be used for locating, the pads on which it rests should be as small as possible (consistent with sufficient surface for proper clamping) and should be easily accessible for cleaning.

2.—*Clearances around the casting.* These should be made ample to accommodate variations in the work. As a rule one-quarter inch on all sides of the rough piece is sufficient, on medium-sized work, such as that machined on horizontal turret lathes. On larger work for the vertical turret lathe or boring mill, one-half inch is none too much and even a little more than this is safer, for larger castings vary greatly in size and the writer has seen a fixture (within the last two years) which had to be machined to obtain sufficient clearance, although it was designed to give one-half inch clearance all around. Needless to say this was made for a large casting, and was used on a boring mill.

3.—*Clamping.* Methods of clamping are many but the plain strap is perhaps more used than any of the others, partly on account of its simplicity but also because it is very efficient. Hook-bolts are good if overhang is not too great, but they are worthless if not well backed up. They are also rather expensive. It is advisable to so design the clamping devices that they can be rapidly operated so that valuable time may not be lost in setting up or taking down the work. It is not considered good practice to use clamping screws which are tapped into a cast-iron body. It is much better to make these in the form of a stud with a nut and washer on the clamp. This brings the wear of the clamping action on steel instead of cast iron.

4.—*Chips.* Provision should be made for the removal of chips so that accumulations of these will not cause trouble. Accessibility to bearing or locating surfaces is important so that cleaning can be readily accomplished. When fixtures are of the pot variety cored openings may be arranged for this purpose. When fixtures are designed for use on vertical boring mills this point is of great importance and must be carefully considered in the design.

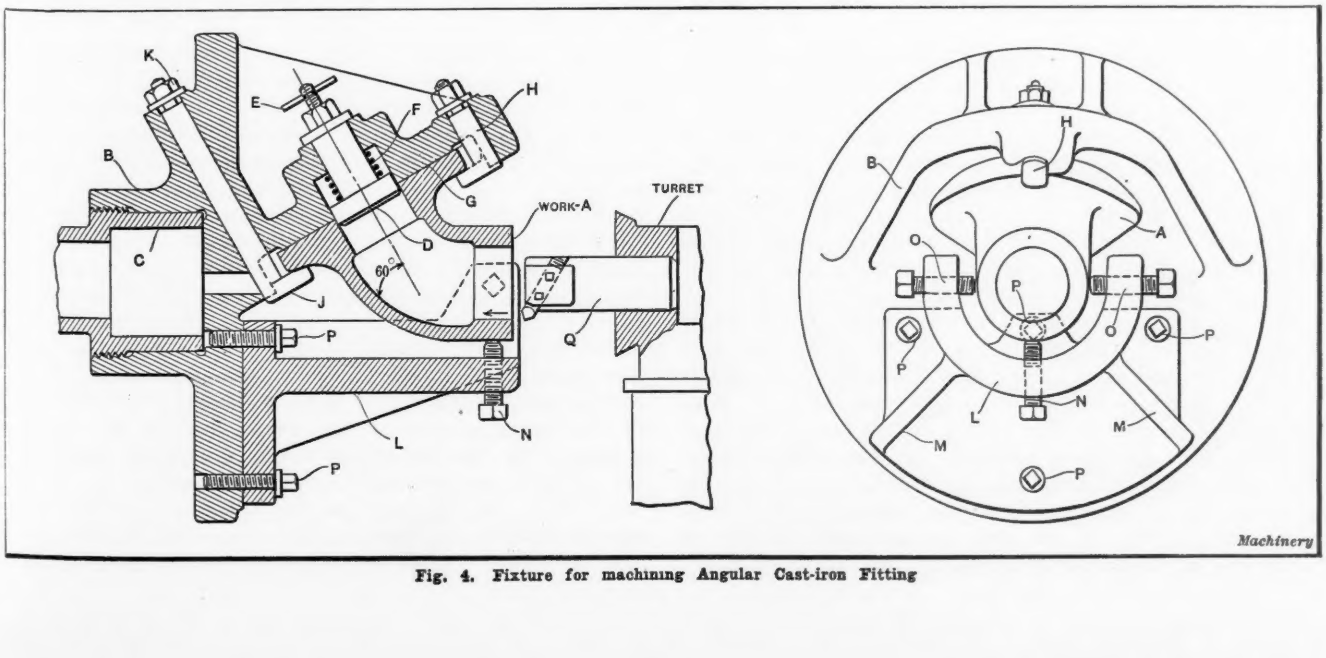


Fig. 4. Fixture for machining Angular Cast-iron Fitting

5.—*Rigidity.* On the horizontal type of machines this point is largely dependent on the overhang from the spindle. Therefore the fixture should be designed in such a way that this will be as short as possible. Ribbing may also be used when needed to give additional stiffness, especially around the clamps, as at these points the strains are excessive and changes may take place in the work itself unless provision is made to neutralize distortion. On the vertical type of machines fixtures should be made of generous proportions to resist the heavy cuts which these machines commonly take.

6.—*Safety.* The operator should be considered at the time the designing is done and not afterward. Projecting lugs, set-screws, etc., should be avoided as far as practicable, especially when their location is at the outer portion of the fixture. Lugs can be easily made so that they have round corners which will not catch in the operator's clothing, and set-screws of the hollow variety may now be obtained in many different forms suited to almost all conditions.

7.—*Cost.* This should be to a certain extent proportional to the accuracy required in the finished work and also to the number of pieces of one kind which are to be machined. A very elaborate and costly fixture should not be designed for a case calling for only a few pieces as this cost distributed on the work would greatly increase the cost of each piece. When a large number of castings are to be handled, however, the first cost may be almost overlooked and every improvement used which will tend to decrease the production time.

In the examples given herewith attention will be called to some of the important points in design and construction, faults will be emphasized, and suggestions made. It should be borne in mind that the examples illustrated have been selected with a view to simplicity rather than complexity of design, so that basic principles will be readily grasped.

Chucking Fixture for a Rectangular Aluminum Casting

The work shown at *A* in Fig. 1 is an aluminum cap for an electric generator. The casting is somewhat rectangular with round corners and is of rather thin section with practically no reinforcement in the shape of ribs. No work has been done upon it previous to this setting so that the casting is in the rough. The machining necessary for this series of turret lathe operations consists of boring, reaming and facing the inner hub; facing the rim and sizing the segmental circular tongues on the face of the rim. An accurate job was required, and no distortion of the casting was permissible.

The work was placed in the fixture so that it rested on the three fixed pads *E* located at the corners, and a spring pin *F* acted as an adjustable support at the other corner. The coil spring under the pin is just strong enough to insure positive contact with the work without danger of springing. The set-screw *L* is of the hollow type and serves to lock the pin securely in position. The side and end locations of the work are determined by the pins *G* and *H* which are flatted off to form a knife-edge where they touch the casting. This arrangement causes them to sink in and prevents any tendency to pull out of the fixture. It will be noted that these pins are set into the blocks *J* and *K* which form a solid backing and prevent springing. A steel block *P* is screwed to a finished pad on the fixture body and is doweled in place. Two knife-edged clamps *Q* fit slots in the block and are pivoted on the pins *S*. They are forced into the casting by means of the hollow set-screws *R*, and have coil springs for the purpose of keeping them back when not in use. In connection with these clamps, attention is called to the points on which they pivot; these are placed well back from the knife-edge so that the clamping action also has a pulling-in tendency. As a means of support for the center of the work, the three spring pins *M* are provided, these being arranged in the same manner as the pin *F*, and locked in position by the set-screws *N*. The body of the fixture *W* is well ribbed up at the rear and is bored out and threaded to fit the spindle *X*. A tool steel, hardened and ground bushing *T* is forced into the center of the body, and acts as a guide for the boring and reaming bars. The pilot *U* of the floating reamer *V* is shown in position.

After this fixture had been completed it was tested and was found unsatisfactory, due to the spring of the work at the clamping points *B*. In order to remedy this defect, a pair of special supporting jacks were made such as shown in Fig. 1A. Two steel vee-blocks *C* were turned down and threaded with right- and left-hand threads, respectively, to fit the knurled collar *D*. These jacks were placed in position in the casting before it was placed in the fixture, and were tightened by the fingers, a piece of drill rod being used for the final pressure. By the use of this device a perfectly rigid effect was produced and the work obtained thereafter was entirely satisfactory. In the design of this fixture as a whole, attention is called to the freedom from projecting set-screws, and other protuberances likely to catch in the operator's clothing.

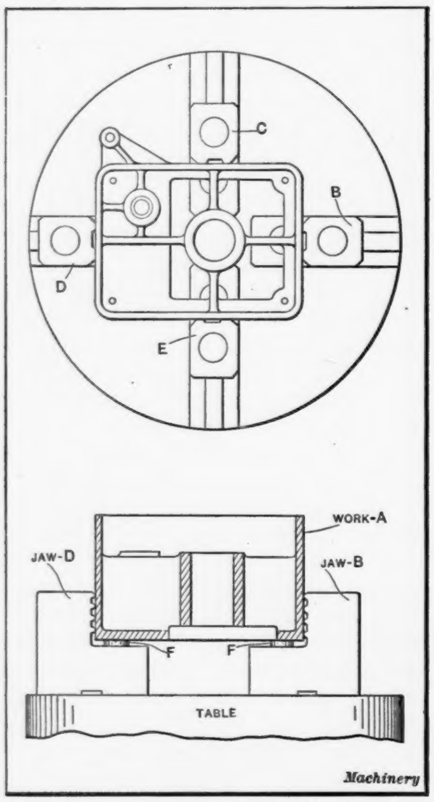


Fig. 5. Use of Four-jaw Chuck for holding Rectangular Work on a Vertical Lathe or Boring Mill

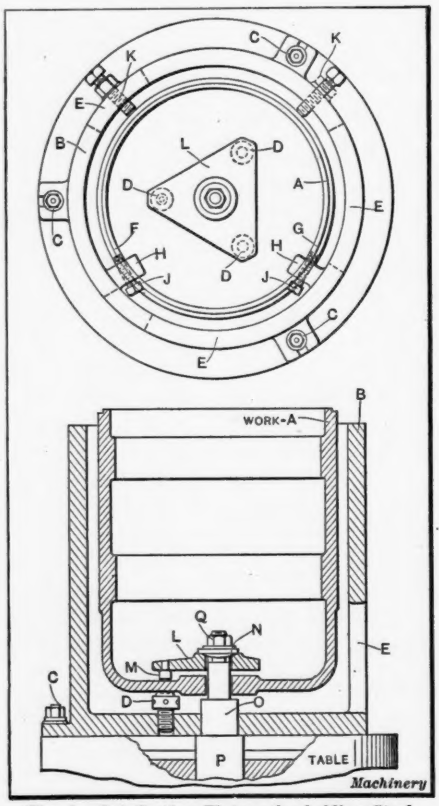


Fig. 6. Pot Casting Fixture for holding Steel Castings on Vertical Turret Lathe

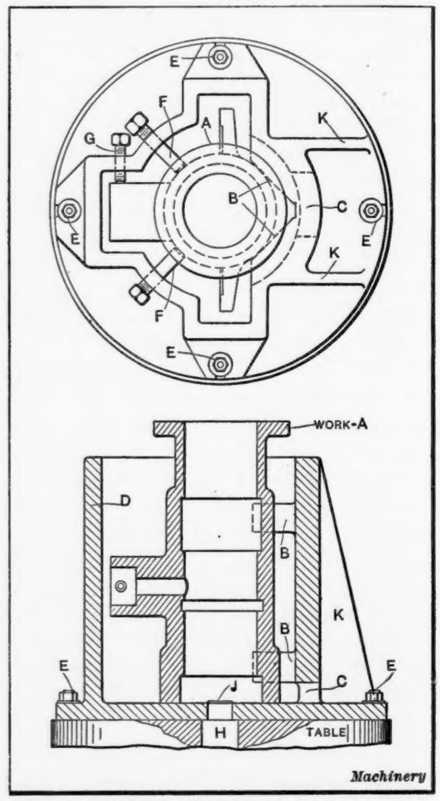


Fig. 7. Pot Casting Fixture for holding Irregular Steel Castings on Vertical Turret Lathe

Special Fixture for a Bearing Bracket

The work *A* shown in Fig. 2 is a cast-iron bearing bracket of somewhat peculiar shape. This has been planed in a previous setting, on the base *D*, and the tongue *B* has also been machined to size. The body of the fixture *N*, made of cast iron, is screwed to the spindle *O* of a horizontal turret lathe. It was faced off in position on the machine so that the face would be perfectly square with the spindle. The semicircular pot casting *C*, carefully located on it by the dowels *H*, is held in place by the screws *G* which enter it from the rear. The work *A* is located on the face of this casting by the tongue *B* which fits a slot cut to receive it. The clamps *E* are of steel and are slotted so that they can be pulled back out of the way when placing the work in position or removing it. The studs *F* are threaded to a tight fit in the casting *C*, and are provided with nuts and washers which bear on the clamps. In this construction the wear due to the operation of the clamps all comes on the steel of the screw rather than on the cast iron, this tending to make the life much longer, and the up-keep better. The lugs on which the ends of the clamps bear are slotted in order to prevent twisting while they are being tightened. These slots are not machined but are cast and afterward smoothed out with a coarse file. The pin *J* in the body of the casting simply acts as a longitudinal stop.

Partly as a protection to the operator and partly as a counterbalance, the segmental piece *R* is screwed to the body by the four screws *S*. This arrangement is valuable because the work is revolving at a fairly good speed (120 R. P. M.) so that good balance is important, and danger to the operator is avoided on account of the guard over the projecting lugs on the work. Attention is called to the accessibility for cleaning the locating surfaces and also to the ease with which a wrench can be used on the clamping nuts. A point in the design which could be improved is the amount of surface used for locating. Small pads under the clamping surfaces and a rim on each side of the tongue would have been ample and could have been kept clean more easily. A tool steel bushing *K* is forced into the body of the fixture and acts as a guide for the pilot *L* of the boring-bar, which greatly assists in preventing chatter while the tool *M* is cutting. The work accomplished in this fixture was satisfactory.

High Speed Fixture for a Bronze Bearing

The bronze bearing shown at *A* in Fig. 3 has been previously machined on the dovetail portion, and it is of importance that the bearing should be in a fixed relation and parallel with this dovetail. As the hole is of small size and the work of bronze, it is necessary that the fixture should run at high speed in order to produce the work in a reasonable time. The body of the fixture *B* is made of cast iron and is fitted to the spindle *C* of a horizontal turret lathe. A steel locating block *E* is fitted to the dovetail of the work and is fastened into its seat in the body by the screws *H*. Two screws *F* are tapped into the dovetail gib *G*, so that they can be used to tighten the work in the fixture without chance of distortion. The pin *J* acts as a longitudinal stop. The lugs *K* are provided for the purpose of balancing the fixture so that it will run without vibration which might otherwise be caused by the high speed and spindle overhang. It will be noted that the outside of the fixture is smooth, thus offering no danger to the operator. Obviously a socket wrench is used to tighten the gibs which secure the work in position. A tool steel hardened and ground bushing is forced into the body at *D* and acts as a guide to the boring-bar *L* which is necessarily small and needs support. The other end of the bar is held by the bushing *M* in the turret hole. This fixture is quite simple but the method used is a little out of the ordinary. It should be noted that the clamping device is efficient and does not tend in any way to distort the work. Its action is in two directions on account of the angle of the dovetail and therefore makes a positive location, as it crowds the work into the dovetail and draws it back at the same time. The fixture was used with satisfaction.

Fixture for an Angular Cast-iron Fitting

The rather awkward piece of work shown at *A* in Fig. 4 is an angular cast-iron fitting which has been previously machined at *G* and had the hole at this end bored. The angle required between the two openings is sixty degrees. The machine to which this fixture is fitted was a horizontal turret lathe. The body of the fixture *B* is of cast iron and is screwed to the spindle *C* in the regular way. The angular pad which receives the finished portion *G* of the casting is machined to give the correct relation between the holes in the joint. A spring plunger *D* is located centrally in this pad, and serves to locate the work in relation to the previously bored hole. The pin *E* is used to pull the plunger back when placing the work in position. The hook-bolts *H* and *J* grip the piece by the flange and hold it firmly against the locating pad. It will be noted that *J* passes through and is operated by the nut and washer at *K* on the back of the fixture. In order to insure rigidity to the forward portion of the piece where the work is being done, a segmental casting *L* is used, which is secured to the body by the four screws *P*. The set-screws *N* and *O* are cup-pointed, and greatly assist in keeping the work rigid at this end. It will be seen that the bracket is well ribbed up at the points *M* to secure additional stiffness. A plain boring-bar *Q* is held in the turret.

Simple Arrangement Using Four Jaws

The motor bracket casting shown in Fig. 5 is of cast steel and has been previously machined on one of its faces. Four jaws in a chuck of the independent type are used in this setting of the work, and the machine employed is a vertical turret lathe. The bracket which is to be machined is located by the two jaws *B* and *C* which are left set to fit the work. The function of these jaws is to take the place of a vee-block and the other jaws are used for the purpose of holding the work securely. The shape of this piece of work being rectangular, it is feasible to use this method for locating, by allowing them to act as a vee. In action, *E* and *D* are brought up alternately until the work is securely held. The surface of the work which has been previously machined is supported by the steel buttons *F* which are positively located in the jaws. This method is adaptable to work which comes along in small lots but it is open to objections. The principal one of these is the possibility of the operator's shifting one of the vee-jaws unconsciously thereby ruining valuable castings. Another is the possibility of variations in the squareness of the machined face with the gripping surface, which will naturally result in work which is not absolutely true. But as a makeshift method when only a few pieces are to be machined, it is satisfactory in the majority of cases unless a very careless workman is employed.

Pot Fixture for an Electrical Piece

The steel casting *A* in Fig. 6 is a piece of work which is handled in the rough, no previous machining having been done on it. This casting is of large size and being of steel is subject to variations in size and shape. As this is the case it is necessary to make suitable provision for these so that compensation may be obtained to suit the various conditions. The vee-principle is made use of in the locating device as far as the cylindrical portion is concerned, the set-screws *K* being adjusted to suit the casting, so that it is centered from the rough exterior. The pot casting *B* is of cast iron and is centered by the plug *P* in the center of the table. This plug is forced into the pot casting at *O*. The work is dropped into the fixture and forced over against the vee-screws *K*, by the square-head set-screws *J* which are tapped into the lugs *H*, and come against the open portion of the work at *F* and *G*. Support is obtained by the screws at the three points *D*, two of which are movable and the third fixed. The movable points are as shown in the lower view, and they are adjusted by means of a piece of drill rod so that the entire casting can be tipped one way or the other to compensate for inequalities in the rough casting. The steel triangular plate washer *L* is fitted with three clamping points *M* which bear on the inside of the rough casting and are equalized so that they all get the same amount of pressure, by the spherical washer *N*, operated by the nut *Q*. The entire fixture is held down on the table of the machine by the tee-bolts *C* which fit the table tee-slots. This fixture gave results which were satisfactory, but the setting-up time required was rather long. The openings *E* shown in the illustration permitted

access to the jack-screws and also allowed cleaning to be easily accomplished. The projecting set-screws are a rather bad feature, as they are dangerous to the operator, but as the speed was not excessive, no trouble was experienced with them. This defect could have been very easily remedied.

Fixture for a Piece of Hydraulic Work

The casting *A* shown in Fig. 7 is of steel and is handled in the rough, no previous machining having been done. This work could have been handled in a three-jaw chuck combination, had it not been for the projecting lugs on the casting, and even these could have been taken care of by cutting away the sides of the jaws. A pot casting method was decided upon instead of this, however, on account of the greater rigidity. The body *D* is of cast iron and is fastened to the table with the four tee-bolts *E*. On one side of this body are two pads *B* which are planed out to form a pair of vee-blocks in which the cylindrical portion of the casting locates. It is forced into position by the screws *F* in the wall of the pot casting. The entire fixture is located on the table by means of the steel plug *H* which fits the table center hole and is forced into the fixture at *J*. A driver is provided in the screw *G* which bears against the hub of the casting and takes the thrust of the cut. Although this is a very simple fixture it illustrates the principle of the vee-block to advantage and should therefore be carefully noted.

The examples illustrated in this article have been selected from a number of fixtures for irregular work, principally because they are of a simple nature and yet illustrate various conditions fully as well as if they were of a complicated structure.

* * *

"MOVIES" MEETING OF THE EFFICIENCY SOCIETY

On the evening of May 26 the Efficiency Society held its regular monthly meeting. This session was designated as a "Movies" meeting, because of the fact that motion pictures and their relation to greater efficiency in the manufacturing and selling interests were discussed. The meeting, which was preceded by a dinner, was held at the Aldine Club, New York City. Major Charles Hine, the presiding officer, stated that it was through the efforts of Fred Hawley, the chairman of the plan and scope committee, that the various films shown to demonstrate the greater efficiency in business that could be secured by the moving picture, were obtained. In connection with the showing of the films, the secretary of the society, Elihu C. Church, made explanatory remarks.

The films shown were divided into two classes, those of interest as efficiency promoters in the factory, and those of interest for promoting selling efficiency. The program under the first class included an interesting film made in the United States Steel Corporation's plant at Gary, Ind., vividly calling attention to accident prevention and self-development for workers in the industries. This was followed by a manufacturing descriptive film from the Ford Motor Co.'s plant; then by a demonstration of the oxygraph. After this followed several microscopic analysis films, in which the motions of a ball balanced on a column of water were analyzed, and the trajectory of a bullet was shown. Time and motion studies were also shown, illustrating the advantages to be gained by the efficiency engineer by analyzing motion through the medium of the moving picture.

As a promoter of selling efficiency, films were shown to illustrate the advantages to be gained by the farmer in using dynamite. In this film the tools and methods of procedure for blasting stumps and felling trees were shown. This was followed by a film showing the operations of a ditch digging machine, bringing out the point that even if impossible for a salesman to show his prospect the actual apparatus, the moving picture film formed a good substitute. The final film was a selling educational film to illustrate various electrical devices as used in the home.

The evening's program did much to demonstrate to the efficiency engineer that the moving picture, like the phonograph and similar inventions that were originally laboratory experiments and later entertainers, are finally evolving into valuable adjuncts to business.

A CONVENIENT TOOL COMPARTMENT

A convenient type of tool-holding compartment especially adapted for screw machine tools is in use in the plant of the Devilbiss Mfg. Co., Toledo, Ohio, manufacturer of atomizers. This tool-holding compartment is of simple arrangement and keeps all the tools separate and all the tools for one job in one place. As shown in the accompanying illustration, it comprises five compartments, each of which contains sixty boxes. On the door of each compartment is a card which gives the job number, the number of tools used, and the number of the box in which these tools are contained.

The screw machine cams are numbered, as they cover several jobs, and are held on a separate rack provided with pins which fit into the large hole in the cam. All collets,

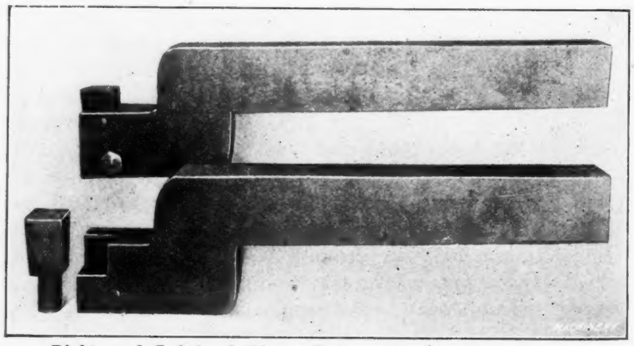
A Convenient Tool Compartment

spring fingers and standard tools are held in racks inclined at an angle of about 45 degrees, which form the last compartment of this row. These racks are arranged in shelf form and are spaced so as to give plenty of room for all the tools. There are spaces for six tools in a row. The special feed tubes are held on the rack shown to the left of the compartment. D. T. H.

* * *

A NON-CHATTER PLANER TOOL

To overcome the chattering encountered on a hard job of planing, the Stockbridge Machine Co. of Worcester, Mass., made a special planer tool with an inserted cutter, shown in the accompanying illustration. The illustration shows two of these tools, right- and left-hand; one has been disassembled and the other is shown with the cutter in place. The tool-holder is of the familiar gooseneck form and the cutter is held in by a clamping bolt at the side. The cutter



Right- and Left-hand Planer Tools made to obviate Chatter

is square in section and fits snugly in a machined section of the tool-holder, being supported on two sides. A round shank is provided that fits into a corresponding hole in the tool-holder. A section of the round hole extends through a slip bushing through which the clamping bolt passes. Thus, when the clamping bolt is tightened, it pulls against the shank of the tool and binds it firmly in place. In using this type of planer tool, there is not the slightest tendency to chatter.

C. L. L.

ELECTRIC ARC WELDING*

APPLICATION OF THE CARBON AND METALLIC ARC IN CUTTING AND WELDING

BY ALAN M. BENNETT†

ELECTRIC arc welding as a means of uniting metals—particularly iron and steel—has been rapidly developed in the past few years, and apparatus for doing this work is now a standard product with a number of manufacturing concerns. This process of welding is particularly applicable to certain classes of work encountered in foundries, railroad shops, tank and boiler shops, steel mills, locomotive shops, and shipyards; and the demand for welding apparatus from these sources is well established. In addition to the field covered by these industries, where the use of this process has become more or less standardized, there are countless other lines of manufacture, each representing a great variety of work to which arc welding is adapted.

Various methods of using the arc for welding have been devised from time to time, the majority of which have met with indifferent success. At the present day practically all welding, in this country at least, is confined to the method in which an electrode and the object to be welded are connected in a simple electric circuit, and an arc of limited size is drawn between the two by bringing the electrode in contact with the work at the point at which the weld is to be made. The size of the arc is capable of adjustment to suit various classes and conditions of work.

The Carbon Arc

In practice there are two methods of applying this process to the making of welds and the cutting of metals. In the first, which makes use of the carbon arc, a rod of graphite forms the electrode; and the arc drawn between this rod and the work heats the latter to the point of fusion. This method is used for cutting or burning off metal, and is the simplest application of the arc. Its principal use is for reducing scrap material to sizes capable of being easily handled, and in foundries for cutting risers and fins from large castings. By extending this process of fusion and introducing pieces of metal within the influence of the arc, actual welding or building up of the work is accomplished. The metal supplied, which may be either in the form of small pieces of scrap material or a rod held in the operator's hand, is fused and unites with that part of the work already raised to a molten state by the heat of the arc, forming a solid mass of even structure upon cooling.

The principal field for the use of the carbon arc is in foundries and steel mills, for the repair of broken and imperfect castings of large size. The loss from this source, which is always high, can be reduced to a very small percentage, as castings containing blow-holes, cracks, shorts, etc., can readily be repaired with a small expenditure for material and labor. For all work of this nature in which the carbon arc is used, comparatively heavy currents are required, ranging from 300 to 600 amperes. Owing to the ability to use these heavy currents, and to apply the heat quickly and concentrate it at the required point, the heat generated at any particular point is very intense and the process of cutting or welding becomes a very rapid one.

The Metallic Arc

The second method in this process of welding makes use of a metallic electrode—usually of a soft grade of iron or steel—which during the operation of welding is fused by the heat of the arc and carried over in the form of small globules that are deposited at the point on the work from which the arc rises. The work itself is raised to a state of incandescence at this point, and the fused metal unites with it as it flows from the electrode. The operation of welding by this method is very rapid, as the fusing of the electrode is continuous after the arc is started, the drops of molten metal following each other in close succession. This method is extensively used in all classes of repair and reclamation work, such as filling in cracks of broken castings, building up the worn parts of rolls and rails, repairing cracks in boilers, patching locomotive fireboxes, and in many industries as a manufacturing means in the process of getting out the finished product. Examples of this latter use are the welding of heads and branches to tanks, joining the seams of tanks and boilers, welding fireboxes, flue sheets, boiler tubes, etc., and all classes of pipe and sheet metal work.

The current required for the metallic arc is small compared with that used in connection with the carbon arc, rarely exceeding 175 amperes for the heavier classes of work just described, and ranging from this down to as low as from 12 to 15 amperes for

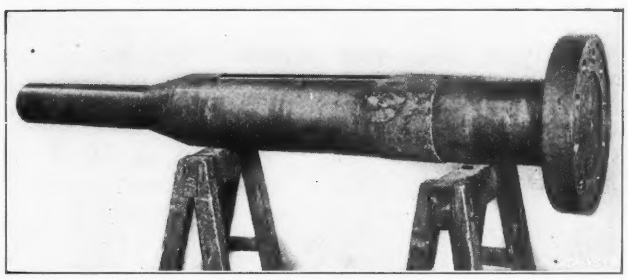


Fig. 1. A Built-up Fit on an Armature Shaft done with the Metallic Arc

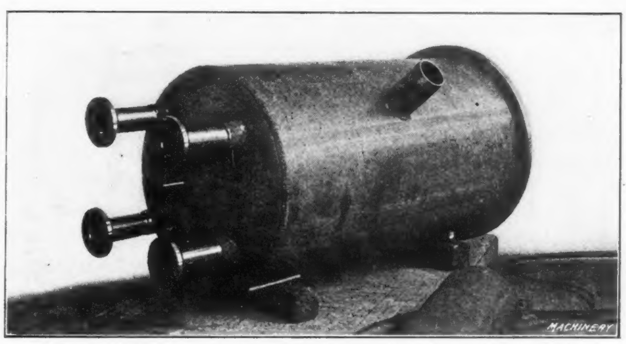


Fig. 2. Head, Flange and Branches welded in a 42-inch Tank with the Metallic Arc

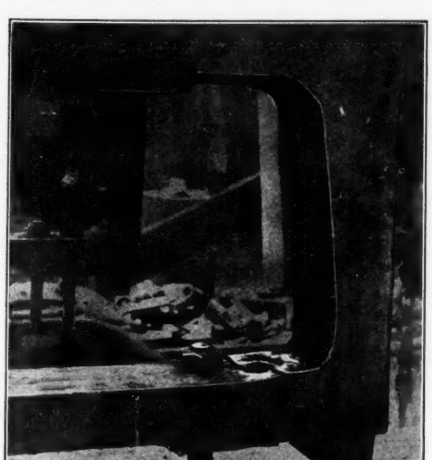


Fig. 3. Fractured Section of Locomotive Frame before repairing

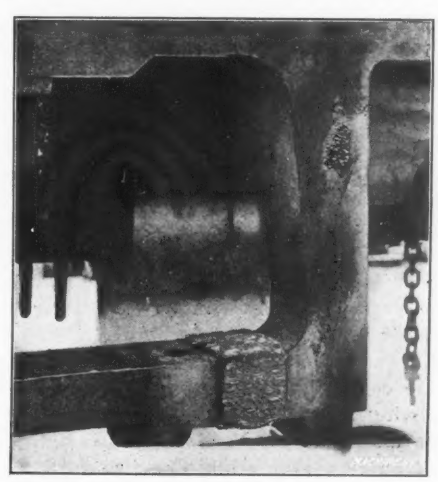


Fig. 4. Section of Locomotive Frame after repairing

* For other articles on electric welding which have appeared in MACHINERY, see "Point and Ridge Method of Electric Welding," September, 1911; "Electric Butt Welding," October, 1910; "Electric Welding of Copper, Brass and Aluminum," March, 1910; "Electric Welding," February, 1909; "Electric Welding of Tools," October, 1908; "Electric Welding of Dissimilar Metals," July, 1908; "Some Examples of Electric Welding," April, 1908; and "Notes on Electric Welding," April, 1903.

† Address: 324 Prospect St., Westfield, N. J.

thin sheet metal work. The size of the electrode used also varies with the nature of the work and current required, the average being from 3/32 to 1/8 inch in diameter. That it is necessary in every case to have a proper relation between the current strength and the size of the electrode can be seen, when it is considered that the heat of the arc must be sufficient to raise a spot on the work to the point of fusion, in order that there may be actual union of the metal from the electrode with the work. If this condition of right temperature does not obtain, there will be an imperfect union of the oncoming metal with the work, and a poor weld will be the result. On the other hand, if the metal is overheated there is danger of burning it. Oxidation also takes place more rapidly, thus impairing the weld, and heavier heating and cooling strains are set up in the metal. The current must, therefore, be regulated to bring about the condition of a proper temperature rise in the work, and the size of the electrode should be selected to carry this current without danger of its being overheated

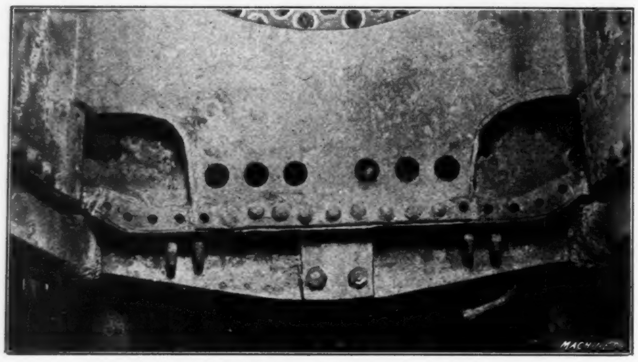


Fig. 5. Fractured Mud-ring of Locomotive Firebox prepared for making the Welds

and oxidized. On the other hand, the size of the electrode must not be too large for the current used, as this will result in slow and imperfect fusion, and equally slow and unsatisfactory welds.

Combined Use of Arc

In many cases, and more particularly in repair work, it frequently becomes necessary to remove parts of the metal at the place where the weld is to be made. For example, to widen out a crack in order that the metal from the electrode may be more readily deposited in it; or to cut out a burned, broken or worn spot for the insertion of new material. This operation of cutting is most readily performed by means of the carbon arc. In such work, therefore, the alternate use of the carbon and metallic arcs becomes desirable and to meet this requirement, as well as to make the outfit as general in its application as possible, means are usually provided whereby both classes of welding can be done from the same outfit. This feature also makes preheating possible, by which means work of large section is raised in temperature by use of the carbon arc, before the welding is actually done. The operation of welding on the hot metal results in the strains being more evenly distributed, both during the process of welding and when the work is cooling off. Welds of greater strength are thus obtained, and the structure of the metal in the weld is more homogeneous with that of the surrounding parts.

Description of Apparatus

The simplest possible outfit for welding would consist of a source of direct-current supply, an adjustable resistance for regulating the current, and an electrode holder. In practice, for reasons which will be explained later, the current is usually furnished by a low voltage generator which may be driven by a motor, engine or belt. In addition, the outfit usually includes a switchboard having on it the starting apparatus for the motor end of the outfit, if motor driven; the control and indicating apparatus for the generator, consisting of a field regulator, voltmeter, and ammeter; and the regulating apparatus for the arc circuits, consisting of a set of current regulating switches with resistance, and usually some form of automatic switch or contactor.

The generator should be compound wound in order that the voltage may be maintained constant under varying load. The need for close voltage regulation will be found to be greatest in connection with the metallic arc, and to increase as the size of the arc and the amount of current used decreases. The smaller arcs will be found to be very sensitive to even the slightest voltage variation, the direct result being an uneven deposit of metal, and burnt welds in the case of very light work. With the carbon arc, where the current used is generally large and where a certain amount of current regulation can be had by lengthening or shortening the arc, the need for close voltage regulation is not so great.

Of the resistance, a certain part is in circuit with the arc at all times when working, this resistance causing the difference between the voltage drop in the arc and the terminal voltage of the machine. It will vary with the amount of current required for welding, and is adjusted by the current regulating switch. When no contactor is employed in the arc circuit, the current at the time the arc is started is limited only by the resistance in that circuit, which is the amount required for welding. This may be of low value, particularly when using a heavy current. There is, therefore, danger of short-circuiting the generator until the arc is established and its resistance introduced into the circuit. The function of the contactor in the arc circuit is to cut out resistance after the arc is established, leaving in the circuit for welding that amount previously determined from the current to be used. By this means the chance for short-circuit is removed, and the apparatus made more automatic in its operation.

After the current is adjusted to give the size of arc needed, no further adjustment is necessary and the arc may be drawn and broken at will, the automatic character of the apparatus always insuring a return to normal conditions. By this means the operator is relieved of all concern as to current regulation, and his whole attention may be given to directing the arc over the work. The operation of welding by either of the methods described makes necessary the renewal of the electrode, though the rate at which the metallic electrode is consumed—owing to the fact that it constitutes the filling material—is much more rapid than that of the graphite rod. To facilitate the act of renewal or of feeding down as it is consumed, the rod forming the electrode is secured to a holder by some form of clamp that readily permits of its being re-

Fig. 6. The Completed Weld with Sections of the Throat Sheet replaced

leased. The holder is designed to carry the current to the electrode with the least amount of heating of the operator's hand.

Owing to the intense nature of the light and heat rays from the arc, the necessity for careful protection of the operator's hands, face and eyes is very important. This is particularly so in the case of the carbon arc, where the volume of light and heat is very great. Heavy gloves serve to protect the hands, while for the face, some form of shield held in the hand or supported from the head is generally used. This is provided with an opening filled with several thicknesses of ruby or blue glass, which afford protection to the eyes and still permit of the welding operation being closely followed.

Potential Required for Welding

The potential which has been found to give the most satisfactory results for welding varies from 65 to 75 volts. A

higher potential can, of course, be used, but as the drop in the arc rarely exceeds 65 volts, a potential in excess of this would have to be reduced by means of resistance in series with the arc. The wasteful effect of using a higher voltage, or of welding directly from shop or commercial circuits by means of resistance banks or water rheostats can be seen. The higher the voltage of the circuit from which welding is done, the greater the amount of resistance needed and the greater the energy loss due to this resistance. Assuming that 75 volts is the maximum required for all cases of ordinary welding, if a 220 volt circuit is used for this purpose the efficiency is seen to be approximately 33 per cent, while at 500 volts it is as low as 15 per cent. It will also be found that when heavy currents—such as are required for welding—are taken directly from the line, serious voltage fluctuations will result, with corresponding ill effects on the apparatus connected to the line.

Flexibility of the System

Any number of operators may weld from the same outfit, each working independently of the other and taking the

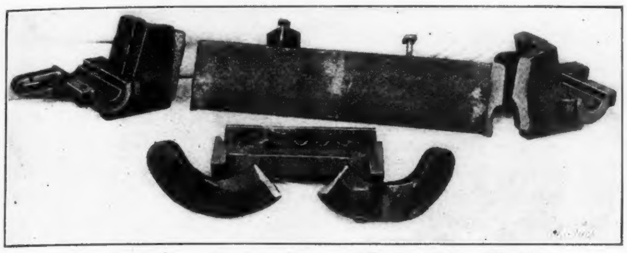


Fig. 7. Broken Casting from a Wood-working Machine

amount of current required for his own particular work, the self-regulating feature of the generator insuring a constant voltage. All of the arc circuits may be taken from the one welding panel or they may be divided among several smaller panels, which may be located at various centers at which it may be desired to do welding, these panels being connected by leads through the shop to the main panel. The latter, in this case, would contain only the motor and generator control apparatus. This arrangement is particularly desirable in locomotive and railroad shops, where the majority of the work is of such a nature that it cannot be moved around conveniently for welding. For doing work of this nature, the electrode holder is often fitted with leads of sufficient length to allow the work to be reached.

Welding can thus be done up to any distance from the outfit, the only limit being the allowable voltage drop in the lines to the work and the electrode. This, in turn, can be regulated to a certain extent by increasing the size of the cable as the distance increases. Beyond 500 or 600 feet, however, this method is hardly practicable for any work other than that which can be done with the metallic electrode, as the size of the cable required for carbon work with its large currents would increase to such an extent that its cost would be prohibitive and the handling of the cable exceedingly difficult. To meet conditions of this character a complete portable outfit consisting of generating and regulating apparatus, mounted on a truck that can be moved from place to place, is most appropriate. For land use the generator end of such an outfit is usually motor driven, while for marine work steam-driven outfits mounted on barges afford the most convenient arrangement.

Special Features

In connecting the work and the electrode in the welding circuit, the former should be connected to the positive side of the source of supply. There are two reasons for this, the first being that the positive side of the arc is by far the hotter of the two. The point on the work under the action of the arc is thus brought to the required fusing temperature in less time than if it were connected to the negative side of the circuit. A better distribution of heat between the electrode and the work is also secured by this means, as the electrode which is usually of small mass compared with the work should naturally be subjected to the less amount of heat. But a more important reason for this arrangement is that when the electrode is made positive the resulting arc is found to be very erratic and unstable, and its control becomes practically impossible.

It is not necessary that the operation of welding always take place in a downward direction. While work with the carbon arc has to be done in this position, due to the flowing of the metal in the weld, the metallic arc can be used as readily on vertical or overhead welds as on downward ones, the only difference being in the rate at which the metal is applied. Owing to the fact that in any position other than downward, the metal is applied against the force of gravity, its rate of flow from the electrode is necessarily slower. This feature of being able to weld with the work in any position occasions a great saving in the amount of handling which would have to be done were it necessary that all welding take place in a downward direction. The arc process of welding is thus seen to be exceedingly flexible in its application. covering work of practically all classes and degrees of accessibility, and this feature greatly facilitates the operation of welding. Handling of the work is reduced to a minimum, and welds are made with an ease and despatch not approached by any other method.

Character of Welds

A large measure of the success attained by this process is accounted for by the satisfactory character of the welds from the standpoint of efficiency. By a proper selection of the grade of filling metal, and the exercise of care in making the weld, it is possible to obtain a tensile strength in the weld of from 95 to 97 per cent of that of the original section. Welds made under the average conditions of everyday work show a tensile strength of from 80 to 90 per cent of the metal. It is possible by slightly reinforcing the welded section to make the strength of the weld even greater than that of the original section. This may be very desirable in many cases where a part has broken through having an undue strain put upon it. By a proper increase of section at this point, a repetition of the break may be avoided. Welds made by this process present a neat and finished appearance. With the metallic arc, the filling metal added from the electrode can be deposited exactly where it is wanted; and with the carbon arc, where the added material is reduced to a molten state in the weld, it may be run at pleasure, extra material being added where needed and the surplus metal being fused

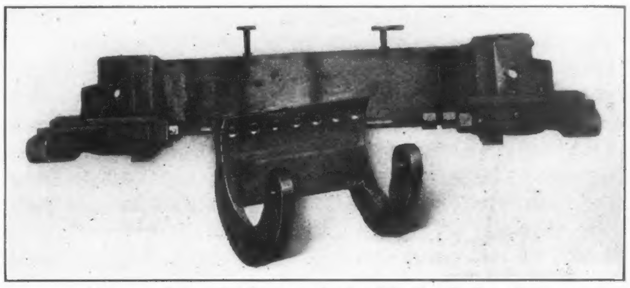


Fig. 8. Same Casting repaired with the Carbon Arc

down to the desired level. In either case, little or no trimming of the finished weld is necessary.

Examples of Work done by the Electric Arc

The illustrations show examples of electric arc welding. While these are of a varied character and show work done with both the carbon and metallic arcs—with a considerable range of current—they do not in any way represent the complete possibilities of the process of arc welding and cutting. Fig. 2 shows an example of tank welding, in which the head, flange and branches of a tank 42 inches in diameter were welded with the metallic arc. The current required was approximately 165 amperes at 70 volts. The finished appearance of the welds and the necessity for little subsequent trimming will be evident from this illustration. Figs. 3 and 4 show a fractured section of a locomotive frame before and after welding. In repairing a break of this nature the metal is cut away along the line of fracture, forming a V-shaped opening. This is filled with the repairing metal. The current required for work of this kind will vary from 500 to

600 amperes. It will be noted that the section has been reinforced where the metal was added.

An armature shaft that had been turned too small at the spider fit is shown in Fig. 1; to remedy this error metal was added by means of the metallic arc, thus increasing the diameter sufficiently to provide for refinishing the fit to the required size. This was done with the metallic arc, using current of approximately 160 amperes. Figs. 5 and 6 show the repair of a fractured mud ring of a locomotive firebox. It will be seen that part of the throat sheet has been cut away in Fig. 5 in order to give access to the mud ring. The fractures in the corners are first opened up with the carbon arc preparatory to welding, and after the weld is completed the sections of the throat sheet are replaced and welded as shown in Fig. 6. In this illustration, it will be noticed that the weld on the right-hand side has been dressed, while that on the left has not. The latter shows the appearance of the weld immediately after making a repair with the metallic arc. Figs. 7 and 8 show a broken casting of a wood planer before and after being repaired with the carbon arc. In cases of this kind the broken part is in use again in a short time, as the delay occasioned by having to replace it with a new casting is avoided.

Cost of Welding

The cost of making welds by this process can best be illustrated by examples covering operations of a common or familiar nature. The work capable of being done by arc welding is of such a varied character that it is not possible to give specific costs for each and every case that may present itself. The cost of generating current, the price paid for labor and the time required for doing any particular job will vary, and this will influence the cost of the weld. Of these three factors the first will be found to vary between the widest limits, the price of labor for the various classes of welding being fairly well standardized, and the time required for making welds not varying greatly where expert welders are employed. The cost of producing the following welds is figured on the basis of labor at 30 cents per hour, and current at 2 cents per kilowatt hour, the voltage in each case being approximately seventy.

A broken shaft 2 inches in diameter was welded and ready for refinishing in one hour; the current used was 350 amperes and the total cost 79 cents. A crack in the back sheet of a locomotive boiler 12 inches long was welded in nine hours, the current used was 175 amperes and the total cost $4.90. The risers on steel casting, 4 by 4 inches in size, were cut off in four minutes; the current used was 350 amperes and the total cost 5.2 cents. A cast-steel tender frame broken in three places was welded in twenty-seven hours; the current used was 300 amperes and the total cost $19.44. The journals of a worn 2-inch armature shaft were built up in three hours; the current used was 165 amperes and the cost $1.59. As an example of straight welding on sheet-metal work, seams on 1/8-inch steel can be welded at the rate of from 15 to 16 feet per hour, and on 1/4-inch steel at the rate of from 12 to 13 feet per hour.

Conclusion

From a consideration of the foregoing the principal reasons for the popularity and success of electric arc welding—both as a repair means and as a manufacturing means—will be readily appreciated. They may be briefly summarized as follows: The adaptability of the process to work of an exceedingly varied character, practically all cases in which iron or steel have to be united being covered by the two methods of using the arc. To this may be added the opposite case, or that of cutting, where the arc is equally effective. The fact that vertical or overhead welds can be made as readily as downward welds greatly increases the availability of the process for certain classes of work, and reduces to a minimum the labor which would otherwise be required for handling. The low cost of welding by this process, as seen when comparison is made with like results obtained by other methods, is a decided argument in its favor. In many cases of repair work, where the electric process is not available, the entire replacing of the broken or worn part would be necessary at a cost many times greater than that required for welding.

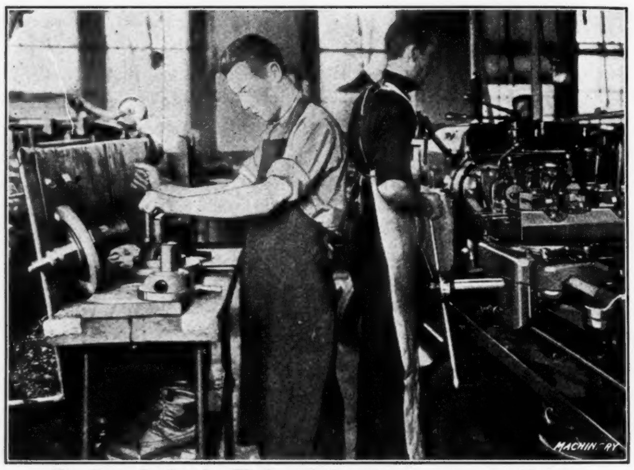
Any number of operators may work from the same outfit up to its capacity. They may be doing different classes of work, and at any distance from the outfit up to limits fixed by the allowable voltage drop in the lines. This feature is particularly effective in those cases where the job is large enough to permit of several operators working at one time. The low voltage used for welding precludes all chance of accident to the operator from contact with current-carrying parts of the apparatus. Welds made by the electric arc possess a degree of strength only slightly below that of the original section, and by reinforcing this can be increased to any desired amount. They present a neat and finished appearance, are homogeneous in structure and may be easily machined. From every standpoint they are of a highly satisfactory character.

* * *

EFFICIENCY IN THE TURRET LATHE DEPARTMENT

The ordinary machine tool represents an investment of several hundred dollars capital, and it would seem that one of the first steps in efficiency would be to keep the machine running as nearly full time as possible. And yet in many shops the operator spends half of his time in preparing work for the machine.

The management of the Brown-Lipe-Chapin Co. at Syracuse, N. Y., has applied efficiency methods in the turret lathe department to Jones & Lamson double-spindle flat turret lathe operation, as shown in the illustration. The work consists



The Boy chucks the Work and the Operator runs the Machine

in machining two diameters, the sides of two flanges and the end of a differential gear housing casting. In chucking the work, the pieces are first put on a faceplate and thus held on the spindle of the machine. To save the operator's time, who is a specialist on this machine, a boy is employed to chuck and unchuck the work. He works back to back with the operator and as soon as one piece is finished the operator passes it to the boy who in exchange gives the operator a piece chucked and ready for the machine. The proficiency that these two men display in working together on this job is remarkable. Notwithstanding the fact that the length is held to within 0.005 inch and the diameter to 0.0005 inch, these operators regularly produce two finished castings in four minutes. In a recent test for speed they turned out forty of the housings in thirty minutes. C. L. L.

* * *

Copper can be welded by the oxy-hydrogen blowpipe by placing two pieces of copper in position so that they can be heated at the proper point by the blowpipe until the requisite degree of softness is attained. Complete reduction is then effected in the flame by the use of purified hydrogen, and the welding is completed by hammering. The joint is said to be invisible and the metal at the weld is claimed to be as homogeneous in every way as the remainder of the metal welded.

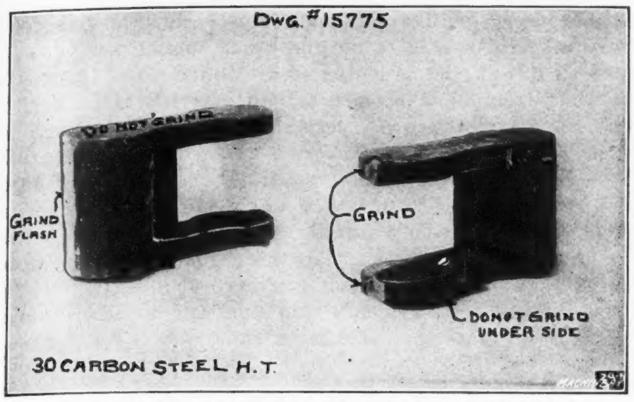


Fig. 1. Forging with "Do Not Grind" Surfaces to be finished in a Subsequent Operation

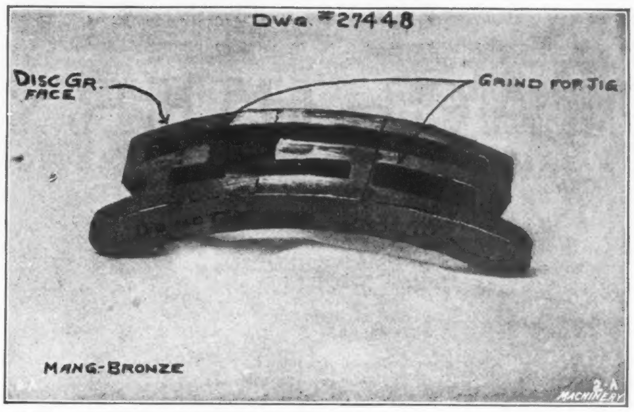


Fig. 2. Surfaces subsequently machined, which are ground to meet the Requirements of the Jig

THE USE OF PHOTOGRAPHS IN GRINDING AND POLISHING DEPARTMENTS

BY GEORGE B. MORRIS*

Marking up photographs of the finished parts is a unique method of instructing foremen and inspectors that is used in the grinding and polishing departments at the Pierce-Arrow Motor Car Co., Buffalo, N. Y. The photographs are on extra heavy Azo paper (requiring no mounting) 5 by 8 inches in size, the same as the operations cards, and the photographs and cards are filed together. The cost of prints per thousand is surprisingly low. The greatest expense is the preparing of parts for photographing, and right here is the great advantage of the system. It is necessary to study each piece carefully; learn its function and location; determine just what surfaces should be ground or polished, and how much; and cut out needless grinding where surfaces are later machined, as in Fig. 1, where the "Do not grind" surfaces are machined in the next operation. In many cases, even surfaces that are later machined have to be ground, as shown in Fig 2, because of jigs and fixtures. It is not expected of a foreman or inspector to look after these points.

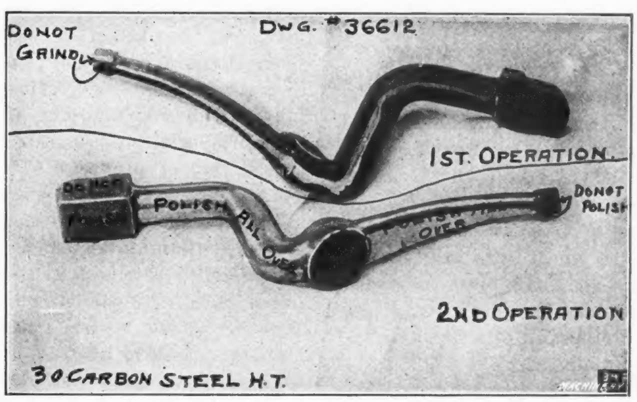


Fig. 3. Instructions for Two Operations included on a Single Card

As a record, the photograph system is excellent; and should a foreman leave, the new man would be greatly assisted by it. Furthermore, there would be no excuse for over- or under-doing a job. As a means of instruction to the workman, the simple words, "John, make like picture" are enough for a new man. The lettering is all done on the photograph, not on the negative, making it possible to use the same negative for several similar parts. A change is also easily made, without exposing another plate, by simply re-marking a new print. The photograph system is being extended to other departments, where one, two or more photographs give instructions in assembling for cases when printed instructions are not clear.

Before taking up this system we outlined two other methods, which were subsequently discarded. The first of these consisted of marking up blueprints for use in the grinding department, while the second was to supply finished samples of the pieces to be ground to serve as a guide in finishing similar pieces of work. Both of these methods were unsatisfactory, and the latter had the further disadvantage of the expense which it involved. A surprising reduction in manufacturing costs has been brought about by the adoption of the photograph system of issuing instructions, and as this method is capable of quite general application, it would appear that many manufacturing companies would do well to adopt it.

* Safety Engineer, Pierce-Arrow Motor Car Co., 1695 Elmwood Ave., Buffalo, N. Y.

* * *

ALLOYS OF ALUMINUM AND ZINC

Experiments undertaken by Dr. W. Rosenheim and S. L. Archbutt indicate that alloys of aluminum and zinc may be made to resist corrosion very effectively by using zinc free from impurities. The addition of zinc to aluminum facilitates the production of good castings. An alloy containing 25 per cent of zinc can be rolled into bars and drawn into wire. The addition of a small percentage of copper to these aluminum-zinc alloys greatly increases the tensile strength. In general, the alloys should contain not less than 15 per cent of zinc, and if dynamic as well as tensile strength is considered, the alloy should contain not less than 20 per cent zinc. Aluminum-zinc alloys lose strength rapidly as the temperature rises. Even 100 degrees F. produces a very marked effect. Alloys containing from 10 to 30 per cent of zinc can be easily worked by machine tools of all descriptions, and in most cases without the use of cutting lubricants.

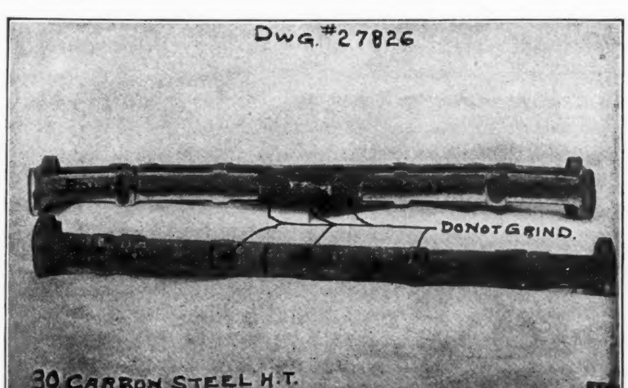


Fig. 4. Simple but Complete Instructions regarding Surfaces to grind, those to polish and those to leave Rough

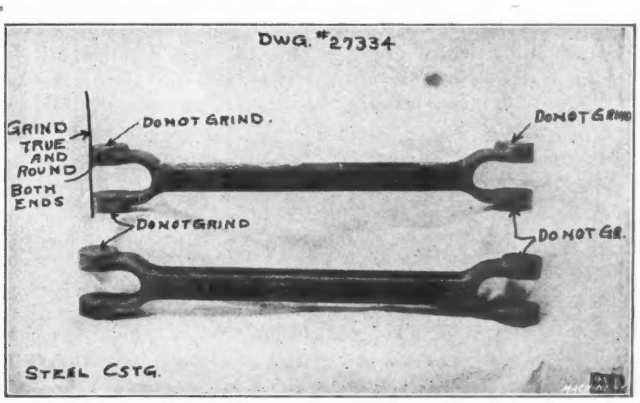


Fig. 5. Instructions that are so Explicit that a New Man cannot misunderstand them

Entered at the Post-Office in New York City as Second-Class Mail Matter

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

140-148 LAFAYETTE STREET, NEW YORK CITY

51-52, CHANCERY LANE, LONDON, ENGLAND

Cable address, Machinery New York

Yearly subscription—Shop edition, $1.00; Engineering edition, $2.00; coated paper, $2.50; Foreign edition, $3.00. The receipt of a subscription is acknowledged by sending the current number. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

JULY, 1914

NET CIRCULATION FOR JUNE, 1914, 25,532 COPIES

GRINDING MULTIPLE DIAMETERS

A curious and interesting development of grinding practice is going forward which apparently will make still greater the revolution effected in machine shop practice by the cylindrical grinding machine. This is grinding to size without lateral traverse of the wheel or work. A few years ago it would have been considered rank heresy to advocate the grinding of work to close limits by feeding the wheel in to the required depth without traversing it back and forth over the work. Now it is the accepted practice for shouldered shafts, crankshafts and other parts having bearings or other cylindrical portions not exceeding five inches in length.

The practice was developed in grinding multiple-throw crankshafts for automobile engines. The bearings between the crank cheeks were short, and very short traverse only was possible. The operation of grinding crank-pins was slow and costly. Cylindrical grinding machines sufficiently heavy and powerful to drive grinding wheels of the full width of the bearings were built, and the practice of grinding crankshafts without lateral traverse was soon recognized as a quick and low-cost method of machining a difficult part.

Now the practice of grinding motor shafts without lateral traverse is accepted as being a practicable and rapid method, quickly acquired by the operator and very satisfactory in results. A further development makes possible the grinding of two or more diameters simultaneously, the wheel having been turned with a diamond to the required diameters.

The limitations of this method are the practicable width of the grinding wheel and the strength and rigidity of the machine. One well-known expert places the limitation of wheel width as being perhaps one foot. The possibilities of rapid production with a stepped wheel one foot wide on electric motor shafts, for instance, are startling. Evidently if three or four diameters on the shaft can be ground simultaneously in about the time now required for one, the grinding time will be cut to one-third or one-fourth what it now is.

* * *

ON GETTING JOBBING WORK

Builders of special machinery often find it difficult to convince prospective customers by mail that they have the skill and equipment to produce the desired apparatus. A booklet illustrating the machine tool equipment and showing a number of examples of machines built will be found one of the best means of pulling business from a doubtful prospect. Every concern looking to do high-grade special work should make a point of photographing every job done, and in time it can easily compile a booklet to slip into letters answering inquiries, that will prove a very effective business getter.

Let these concerns also advertise in the trade papers that they are builders of special machinery and offer to send booklets on application and they will soon find themselves in touch with many who want work done. There is no better way of getting employment at anything than by showing what you have done. The fact that you have done certain things well is pretty good evidence that you can do other things acceptably to those who want them done.

* * *

UNIFICATION OF WEIGHTS AND MEASURES

Some of our English contemporaries have of late devoted considerable space to the metric system, and conservative minds have tried to improve upon the existing English system of weights and measures, so that—while retaining the old names and main units—the benefits of a decimal system could be realized. This seems futile and serves no purpose whatever.

Nor do mere academic discussions of the advantages or defects of the metric system, on the one hand, and the English system, on the other, serve any useful purpose. A uniform system of weights and measures for the whole civilized world is greatly to be desired, and there is little doubt that it will ultimately be achieved. The longer the work of unification is put off, however, the more difficult will it be to accomplish the change. As it is hardly reasonable to expect that the part of the world which uses the metric system will change back to the system used by the English-speaking nations, it seems inevitable that the English-speaking nations must ultimately conform in this matter to the rest of the world, especially as such a change in the opinion of many is in the line of progress.

This editorial is not an argument in favor of the metric system as such, but it is an argument in favor of a *uniform* system of weights and measures which would be a great boon to the industries and to the trade of all nations. When the importance of such a uniform system is recognized, the adoption of the metric system is a foregone conclusion, simply because it is already used by three-fourths of the civilized world.

* * *

DRAWING AND FORMING DIES

Comparatively little definite information has been published in the mechanical journals relating to the drawing of metals in presses. Numerous examples of practical press work are shown every month, but the fundamental principles governing the work have yet to be worked out. In fact, the art of drawing and forming may still be considered, in some respects, to be in its infancy. While an enormous amount of this kind of work is done daily in hundreds of shops in the country, there is still a scarcity of definite information as to the principles involved. Some day this subject will be taken up and thoroughly investigated, as F. W. Taylor investigated the art of cutting metals, and then exact rules and formulas may be worked out governing the drawing of metal sheets into shells. At present the mechanic interested in this work must content himself with studying a few general principles based upon practical experience.

It is possible, however, that even with the knowledge at present available on this subject, it could be treated for publication purposes in a far more comprehensive and analytical manner than has heretofore been done, and right here is an opportunity for men of practical experience, with ability to analyze principles and express themselves in clear language, to contribute to the engineering literature of the day information that would be of great value, because it would be original, practical and in constant demand.

It is a curious fact that on nearly every other mechanical subject there are books dealing with fundamental principles. In punch and die work writers seem to be satisfied with merely showing examples of work that has been done.

THE COEFFICIENT OF MECHANICAL FRICTION

When the surfaces of two bodies are in contact and under pressure, there is resistance to motion of one body on the other, due to the mutual interlocking of the minute projections on the two surfaces. Hence, to obtain relative motion, these projections must be disengaged, abraded or overridden and their resistance to these actions causes sliding friction. Thurston says: "The greatest force with which relative motion is resisted by friction is obtained by multiplying this total pressure (on the contact surfaces) by a *constant* coefficient (of friction) to be determined experimentally for every pair of surfaces of definite character"; and in citing the so-called "laws" of sliding friction, he states that this resisting force is dependent only on the nature of the surfaces and the normal force with which they are pressed together, and is independent of their area of contact, of the velocity of rubbing and of any other conditions than those noted above.

Thurston wrote thirty years ago and his statements were justified by the meager information then available. While later experience and experiment have shown that they are in many respects inaccurate with regard to machine bearings, his broad conclusions still find a place in some text and reference books in which the subject is treated very briefly, and hence they may deceive the young and inexperienced engineer. As a matter of fact, they are true, as a whole, only for surfaces whose normal pressure is low, whose velocity is very moderate and which have little, if any, lubrication—all conditions which are, in general, the reverse of those which the machine designer must meet.

For any two metals of the same character of surface, lubricant and normal pressure, the coefficient of friction is very far from being a constant—as Thurston states—in bearings of different types. On the contrary, it is one of the most variable factors to be found within the whole range of machine design. Take a familiar example: in a high-speed, reciprocating engine, the customary pressures per square inch of projected areas of the bearings may be taken in pounds as, roughly: crosshead guides, 100; shaft bearings, 400; crank-pin, 800; crosshead pin, 2200. Now, the metals in contact in all of the bearings are usually the same and the character of the surfaces is identical, but the allowable normal pressure differs in each case. Why? The only answer is that, for each case, there is a different coefficient of friction. A bearing is so proportioned that at its maximum pressure and velocity its temperature shall not rise above a "working heat" so that "seizing" shall not occur. Now, as the coefficient of friction varies inversely as the normal pressure, it is evident that the less the allowable pressure to prevent heating, the greater the coefficient of friction in that bearing must be—which, broadly, is the reason for the wide variations in normal pressure shown in the foregoing examples.

For machinery in general, the coefficient of friction for the same pair of metals depends upon a large number of conditions. Its value is affected not only by the nature of and the pressure upon the surfaces, but by their temperature and relative velocity, the latter having sometimes a marked effect. Again, the character of the motion and the steadiness or intermittent nature of the pressure influence it. For example, in a shaft bearing, the motion is continuous and the general direction of the pressure is steady; in a crank-pin journal the motion is also continuous, but the pressure changes from one side to the other; and with a crosshead pin, the motion is reciprocating and the pressure intermittent. The steadiness of pressure and the nature of the motion have much influence on the effectiveness of the lubrication. Again, the form of the surfaces—flat or cylindrical—and the character of their contact—through a surface or a line—are both factors of moment. Finally, the nature of the lubricant and the effectiveness of the lubrication are all important; every journal should run on a film of oil.

It is apparent that, for given metals, the coefficient of friction is not a constant, but rather a frequently changing factor or ratio.

NOTES AND COMMENT

The popularity of that type of automobile which has been termed the "cycle car" is on the increase, according to the *Scientific American*. There are now said to be nearly thirty companies building cycle cars in Detroit. Many of these find a ready sale for their products in Great Britain, and one maker has just announced the signing of contracts for 10,000 cars for England. As yet these cars are not very frequently seen on this side of the Atlantic.

A cheap material for making concrete waterproof, which is being used with success in some parts of the country, consists of finely divided iron filings, borings, turnings, etc. The iron has the property of making concrete waterproof because of rusting; the rust fills the pores and seals them up tightly. This simple means of making concrete waterproof has been sold as a trade secret with considerable profit to the promoters. The cost of the process is not as high as of some other waterproofing methods not as effective.

Rifles have been used to punch holes in iron wagon tires in emergencies, but it remained for F. A. Robarge of South Milwaukee, Wis., to use a rifle for the first time to cut down a chimney. A steel chimney of the Rundle Mfg. Co., Milwaukee, composed of sheets about 3/16 inch thick had been broken off by the wind about twenty-five feet from the top, and the broken part hung suspended from the stump. It was considered too dangerous for a steeple jack to climb and cut the part loose, so the rifle man was called on the job. Five or six shots through the supporting shred were sufficient to loosen the hanging piece and send it crashing down to the ground.

Cast iron is a common material of construction that has many characteristics little understood. It can be made glass hard by casting it in contact with chills—that is, cast iron forms of sufficient mass to cool the metal quickly. But if poured in cast-iron molds and removed as soon as the surface has solidified, the casting will be soft and easily machined. It even possesses a slightly malleable property. A still more interesting characteristic is its capacity for hardening when heated and quenched. Lathe and planer tools have been made from permanent mold castings, it is claimed, which, under favorable conditions, equalled the best high-speed steels in cutting performance.

Another giant hydro-aeroplane, rivaling in size the Sikorsky machine, has been built by Messrs. Jeanson and Collieux, in France. The machine is provided with a single boat having a length of 28 feet 6 inches and a beam of 8 feet 6 inches. The aeroplane portion consists of two sets of biplanes arranged in tandem. The span of the wings is 88 feet 6 inches and the total lifting surface, 1560 square feet. The boat body is provided with two 200-horsepower motors, connected with a single air propeller, 16 feet 6 inches in diameter. The total weight of the machine with pilot, assistant pilot and two passengers, and fuel for a thousand-mile (fifteen hours) trip, is slightly over 10,000 pounds.

A German contemporary states that the setting of Portland cement is assumed to be due to the formation of a gel, which ultimately hardens to a lime-aluminate-silicate mass and forms a close-fitting network around any embedded inert material. With concrete, such a network surrounding angular gravel or sand would be stronger than one enclosing rounded grains, and the strength attained with washed sand would be greater than with unwashed, since, in the latter case, the intervening layer of soft clay prevents the surrounding network from directly gripping the grains of sand. Similarly, with ferroconcrete, rust is detrimental as it prevents close contact between the iron and the surrounding gel.

Signs in shops prohibiting workmen from doing something they are likely to do are to be deplored unless means are conveniently provided for doing it in the prescribed way. Then they are not likely to do it in the prohibited way if it is

understood to be contrary to the practice of the shop and signs will not be needed. "Workmen will be discharged who use this grinder without wearing goggles," posted over a grinder used in common is a poor means of discipline if the goggles are not kept close at hand. In practice, the injunction will be ignored. If ignored with impunity, the probability is that cautionary regulations, in general, will not be observed when the convenience of the workmen dictates otherwise.

One of the difficulties with moving picture cameras is that they must be supported by a firm stand while the picture is being taken, in order to prevent vibration. A hand camera for taking moving pictures, however, has been developed in Europe, the front of the camera containing a rapidly rotating gyrostatic wheel which keeps the camera steady in any desired position. The motive power for driving the film and the gyrostat is obtained from cylinders containing compressed air fitted at the back of the camera. A paper describing the device has been read before the Royal Photographic Society in England, and the excellent results obtained by it were also demonstrated at the same time.

Experiments have been made to determine whether lubricating oil "wears out" or not in long-continued service. These tests were made by Professors Carpenter and Sawdon at Cornell University. The tests indicated that oil gains in specific gravity by continued use, as would be expected on account of the loss of volatile constituents. The used oil shows a higher viscosity than new, indicating that it gains in "body" with use. Friction tests showed that new oil has a slightly lower coefficient of friction at low bearing pressures, but the reverse is true for high pressures. The differences, however, are so small that for all practical purposes the coefficient of friction may be taken as being equal for new and old oils.

Germany now uses between forty and fifty million gallons of denatured alcohol a year, of which over thirty million gallons is sold to the general public for burning purposes. France uses about eighteen million gallons, the United States about ten million gallons and the United Kingdom only four million gallons. Denatured alcohol is gaining in favor for general burning purposes, and efforts are being made to use it as a substitute for motor fuel in place of high-priced gasoline. A monograph by Charles A. Crampton entitled, "Production and Use of Denatured Alcohol in Principal Countries," has been published by the United States Government and copies may be obtained from the superintendent of documents, Government Printing Office, Washington, D. C., at 5 cents each.

Wheel spindles of cylindrical grinding machines run up to as much as 1500 feet per minute peripheral speed. The bearings are plain bushings provided with means for collapsing to fit the spindle closely. The rule is to give only 0.001 inch clearance, that is the bearing is only 0.001 inch larger than the grinder spindle. The space for oil film then is only 0.0005 inch around the spindle and thin oil must necessarily be used. Spindles will run without appreciable shake in bearings 0.005 inch larger than the spindle but will run out of true if the running parts are not in perfect dynamic balance. The unbalanced part tends to rotate about the center of gravity, thus making the oil film thicker on one side than on the other. But the eccentric oil film does not remain in the same relation, the result being that the wheel runs out of true.

Vanadium has been used to some extent in brass, having been added in the form of cupro-vanadium. The resulting brass is generally known as "vanadium-bronze." The mechanical properties of this alloy are superior to those of ordinary brasses. The elastic limit is raised and the alloy is harder. At the same time the ductility is not affected to any appreciable extent. Published results of tests of vanadium brasses indicate quite a considerable increase in strength, and it is also stated that cupro-vanadium additions to brass reduce the tendency to corrosion. It is probable that the beneficial effect of vanadium is largely due to its deoxidizing action, but it is difficult to determine the exact effect of vanadium, owing to the comparatively large amounts of aluminum and other metals present in most samples of commercial cupro-vanadium.

The great change that has come in the business of steam engine building is indicated by the experience of one of the well-known concerns in this line. After having enjoyed a deserved reputation as a builder of high-grade automatic steam engines for many years, its business declined in the face of competition to the point that made necessary its discontinuance. The president has seen the work of a lifetime vanish in the march of progress. A melancholy aspect of the case is that he is one who has done much to promote better methods and ideals and to encourage the putting off of the old in favor of the new when the new is better. A large user of the company's engines recently sold it several discarded engines, still in first-class condition, at the price of scrap iron! To find customers for these engines, even at an absurdly low price, apparently will not be easy. The steam turbine, the gas engine and the electric motor have come to stay.

Roller rests for heavy lathe work are used much more abroad than in the United States, and they are used for good and sufficient reasons that should command our adoption of the idea. A roller rest will stand much use with little wear. The work revolves freely and is held up to the same height from start to finish of long jobs. This is an important consideration on gun lathes that may carry a gun weighing a hundred tons for weeks. The plain rests used in American shops generally are cheap and that is about the only merit they have. They oppose the movement of the work with unnecessary frictional resistance and wear considerably when supporting heavy parts in motion for several days. The work drops out of line with the lathe centers and the boring tools are affected. Improved steadyrests are greatly needed on heavy lathes. They require all the care in designing and making that any other important part of the lathe receives.

In a summary of the waterpower of various countries, the *Mechanical World* gives the possible horsepower of France as 4,500,000, of which only 800,000 is utilized. About an equal amount of power is available in Italy, but only 30,000 horsepower is utilized. The estimate for Switzerland is incomplete, but about 300,000 horsepower is in use. Germany has 700,000 horsepower available with 100,000 applied. Norway has 900,000 horsepower available, with a large part already developed. In Sweden there is 763,000 horsepower available, but mostly at a considerable distance from any industrial center. In Great Britain 70,000 horsepower is already utilized, and an equal amount in Spain. The resources of Russia are estimated at 11,000,000 horsepower, of which only 85,000 has been developed. The United States is credited with 1,500,000 horsepower, while Japan has 1,000,000, of which 70,000 has been exploited; in India 50,000 horsepower has already been developed.

A leading machine tool builder once solved a problem in screw cutting in an ingenious manner. He was required to cut a large long lead-screw to a metric pitch. The limits of tolerance were so narrow that the common translating gears, including a 127-tooth gear, would not exactly produce the required pitch when working under normal shop conditions. The difficulty was overcome by expanding the lead-screw of the lathe which is about sixty feet long, by heating it with a steam coil. The shop temperature was maintained equable night and day, while the screw was being cut, and the lead-screw was kept several degrees warmer by the steam coil boxed in with the screw as far as possible. A multiplying indicator on the end of the bed showed the amount of expansion obtained, and this was maintained as uniformly as possible. In this way the screw was chased to a very close approximation of the desired metric pitch. Its diameter was six inches and length about forty feet.

FLUTING HOBS

BY GUY H. GARDNER*

I recently received a letter asking for information relative to the fluting of hobs. The text ran as follows: "I have turned and threaded a hob of 2.125 inches pitch diameter and 15 degrees 30 minutes thread angle. I intended to mill twelve spiral flutes in the hob at right angles to the thread. I found the lead for these flutes by multiplying the pitch circumference by the cotangent of 15 degrees 30 minutes, which gives 24.0622 inches for the lead. Gearing the milling machine for a lead of 24 inches, and trying the job with a scriber in place of the cutter, I found that there are neither 12 nor 13 teeth in one complete turn of the hob thread; I judge that there are approximately 12 15/16 teeth to each turn. I can set my relieving attachment for 12 teeth or for 13 teeth, but not for any intermediate number. I am anxious to do a good job; how can I do it?"

The writer of the letter quoted has met with a difficulty which is practically unknown in large shops where hobs constitute one of the regular products, as such shops have skilled designers to make the necessary calculations, and in some cases, at least, relieving machines are available which are equipped with special differential gearing to enable them to handle teeth of fractional pitch. For men like my correspondent who only make a hob occasionally, the problem is somewhat difficult; and if one may judge from the hobs seen in use, it would appear that a satisfactory solution of the problem is not always arrived at. The purpose of this article is to point out one simple way in which work of this nature may be done on an ordinary relieving lathe.

It is first necessary to find the number of teeth that would be formed in each turn of the hob thread if the flutes were milled at right angles to the threads. Any one who can use a table of logarithms can easily ascertain this number by dividing the number of flutes in the hob by the square of the cosine of the thread angle, *i. e.*, the angle which the thread makes with a line perpendicular to the axis of the hob. The table presented in this connection provides an even easier method of determining the number of teeth for the angles given. In using it, it is only necessary to find the number corresponding to the thread angle and multiply it by the number of flutes. For the present case the result would be $1.0769 \times 12 = 12.9228$.

FACTORS FOR DETERMINING NUMBER OF TEETH FOR VARIOUS THREAD ANGLES

Thread Angle, Degrees	Factor	Thread Angle, Degrees	Factor	Thread Angle, Degrees	Factor	Thread Angle, Degrees	Factor	Thread Angl., Degrees	Factor
5	1.0076	27	1.2596	44	1.9326	49¾	2.3953	55	3.0396
6	1.0110	28	1.2827	44½	1.9657	50	2.4203	55¼	3.0779
7	1.0150	29	1.3073	45	2	50¼	2.4457	55½	3.1170
8	1.0198	30	1⅓	45¼	2.0176	50½	2.4716	55¾	3.1571
9	1.0251	31	1.3612	45½	2.0356	50¾	2.4980	56	3.1980
10	1.0310	32	1.3905	45¾	2.0538	51	2.5250	56¼	3.2398
11	1.0378	33	1.4217	46	2.0723	51¼	2.5525	56½	3.2826
12	1.0452	34	1.4550	46¼	2.0912	51½	2.5806	56¾	3.3264
13	1.0533	35	1.4903	46½	2.1105	51¾	2.6091	57	3.3712
14	1.0622	36	1.5279	46¾	2.1300	52	2.6383	57¼	3.4170
15	1.0718	37	1.5678	47	2.1500	52¼	2.6680	57½	3.4639
16	1.0822	38	1.6104	47¼	2.1703	52½	2.6984	57¾	3.5119
17	1.0936	39	1.6558	47½	2.1910	52¾	2.7294	58	3.5611
18	1.1057	40	1.7041	47¾	2.2120	53	2.7611	58¼	3.6114
19	1.1186	40½	1.7295	48	2.2335	53¼	2.7934	58½	3.6629
20	1.1326	41	1.7557	48¼	2.2553	53½	2.8263	58¾	3.7147
21	1.1474	41½	1.7827	48½	2.2766	53¾	2.8600	59	3.7698
22	1.1632	42	1.8107	48¾	2.3002	54	2.8944	59¼	3.8253
23	1.1802	42½	1.8397	49	2.3233	54¼	2.9297	59½	3.8821
24	1.1982	43	1.8696	49¼	2.3469	51½	2.9655	59¾	3.9403
25	1.2174	43½	1.9006	49½	2.3709	54¾	3.0021	60	4
26	1.2379	...	......	...	......	...	......	...	......

Machinery

An ordinary relieving attachment cannot be set for this number of teeth, but by making a slight change in the lead of the spiral flutes, we can make them give 13 teeth in each turn of the hob thread. The accompanying illustration shows the method of procedure in determining the necessary change in the lead of the flutes. *AB* is the pitch circumference of the hob, *BC* is the lead of the hob thread and *AC* represents the length of one turn of the thread. Calling *F* the number of flutes milled in the hob, it has already been explained that the number of teeth produced in the length of one turn of the thread *AC* is $\frac{F}{\cos^2 \alpha}$. The line *BD* represents the direction of flutes milled at right angles to the threads *AC*, and *BE* represents the required direction of the flutes to produce exactly 13 teeth in each turn of the hob threads. It will be seen that the flutes *BE* are at an angle β to *BG*. Let *N* represent the number of teeth in a turn of the thread *AC* cut by the flutes having the direction *BE*.

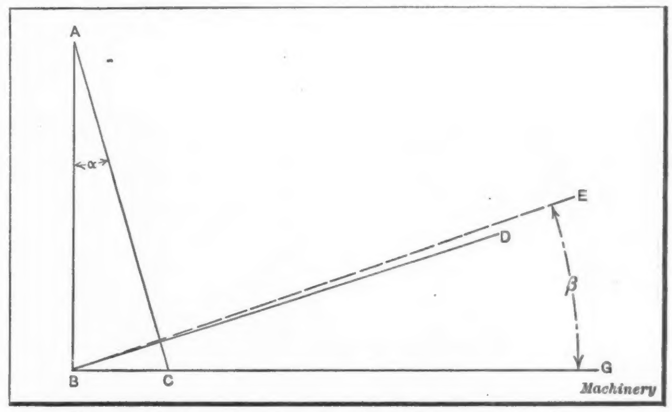


Diagram showing Method of adjusting Flute Angle to give a Whole Number of Teeth

In order to calculate the changed lead of the spiral flutes due to the alteration in their direction, the lead of the hob thread is required; this is usually known or can be found by multiplying the pitch circumference of the hob by the tangent of the thread angle α. In the present case, the lead of the hob thread is represented by *BC* in the accompanying illustration and has a value of 1.8513 inch. The changed lead of the spiral flutes is then found by multiplying the lead of the hob by the number of flutes in the hob and dividing the product by the desired number of teeth minus the number of flutes. Presented in the form of a formula this result would be given by the following:

$$\frac{BC \times F}{N - F} = \frac{1.8513 \times 12}{13 - 12} = 22.2156 \text{ inches.}$$

As 22¼ inches is the nearest available approximation, the milling machine is geared for this lead and the 12 flutes are milled. To find the angle *EBD* by which the direction of the flutes differs from that of the line *BD* which is perpendicular to *AC*, we divide the pitch circumference by the changed lead, the quotient being the value of tangent β. For the present case, β is found to have a value of 16 degrees 42 minutes. Subtracting from this the value of the thread angle α, which is 15 degrees 30 minutes, we find that the flutes are not at right angles to the hob threads by 1 degree 12 minutes. It will be noticed that no alteration of the lead is required when the thread angle α is either 45 or 60 degrees. The same is true when the thread angle is 30 degrees if the number of teeth *F* may be divided by 3 without leaving a remainder.

* * *

The possibilities of cost reduction of manufactured products are not fully grasped by many manufacturers who have been in the business for years. Where a single standardized machine is made in large numbers, special machinery and methods can be introduced with telling effect. The claim is made that the Ford motor car costs the company when ready to turn over to the agents less than $200. Compare this with the alleged costs of the higher priced cars selling for $2000 to $3000. There must be either great inefficiency of production or great profit in the business. As a matter of fact, the average maker's methods are inefficient but his profit is large.

* Address: New London, N. H.

SUB-PRESS DIES FOR ARMATURE MANUFACTURE

SECTIONAL DIES FOR FIELD AND POLE PUNCHINGS, AND FOR ARMATURE DISKS

BY FRED K. HUDSON*

IN the January, 1914, number of MACHINERY, Douglas T. Hamilton described the making and use of one-piece armature-disk dies that are used in the factory of the Robbins & Myers Co., Springfield, Ohio. It is the purpose of the present article to describe the methods for making two interesting sectional sub-press dies that are used in the manufacture of armature disks and field and pole punchings. Fig. 1 shows the punchings and also the 0.025 inch sheet steel from which they are made. Fig. 3 shows the assembled punch and die used for making the field and pole punchings, and Fig. 6 shows the assembled punch and die for blanking and notching the armature disks. The other illustrations show parts of these punches and dies from which the construction will

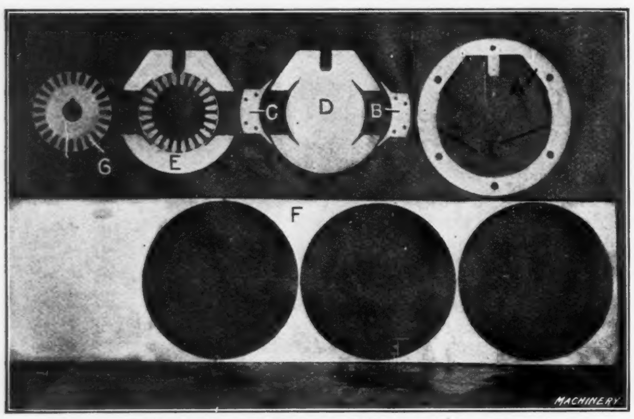


Fig. 1. Field, Pole and Disk Punchings and the Stock from which they are made

be readily understood. The parts A, B, C and D are produced at one stroke of the press. The parts E and F are scrap; and the disk G is stamped from the piece D in a subsequent operation.

The assembled punch and die for making the parts A, B, C and D is illustrated in Fig. 2, and Fig. 3 shows this punch and die taken apart in order that a better idea of the construction may be obtained. In Fig. 4 the lower half of the die is shown with the strippers removed. This illustration also shows the templets for the field and pole punches and the templet drill jig used for drilling the pole punches. The punch for making the field (shown at A in Fig. 1) is made of six sections, comprising one each of parts shown at J and K in Fig. 4 and two each of parts L and M. These sections have flanges on the outside, fastened to a tool steel ring 5/8 inch thick, fillister-head screws and dowel pins being used for this purpose. The ring and flanges are ground to fit into a recess in die-holder N. The pole punches O and P are made 1/8 inch higher than the cutting edge of the field punch and have a flange on the inside. They are screwed and doweled onto a tool steel plate Q, 5/8 inch in thickness, this plate being a sliding fit in the ring on which the sections of the field punch are mounted. Both the ring and plate are doweled to the die-holder N and held in position by fillister-head screws which extend through from the back of the die-holder.

To facilitate grinding the die when it becomes dull, the

* Address: Hayden Ave., Windsor, Conn.

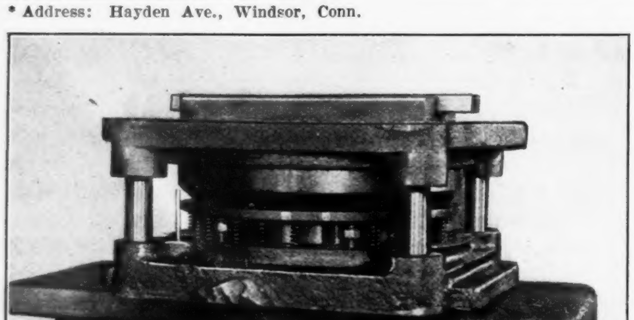


Fig. 2. Assembled Punch and Die for the Field and Pole Punchings

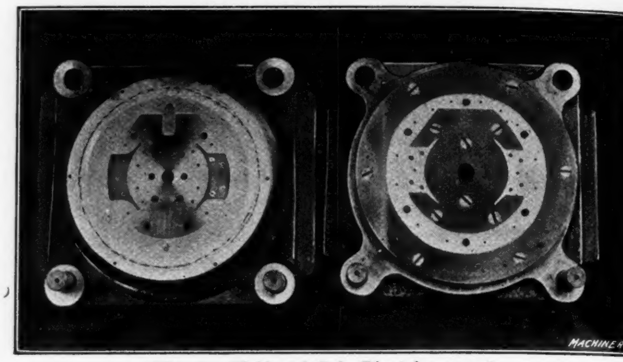


Fig. 3. Field and Pole Die taken apart

screws holding the field punch plate are loosened and the field punch raised to the level of the pole punches, four adjusting screws being provided for this purpose. The dies for the round holes in the field and poles are bushed in the punch sections. This makes replacement an easy matter and the scrap from the holes is allowed to pass down through the die-holder. The spring plate strippers are shown at R and S in Fig. 4. They are held in position by flat-headed screws which have nuts in counterbored holes in the back of the die-holder. Dowel pins are put into the holes to keep the nuts from turning, the method being clearly shown in Fig. 7. Short springs and nuts shown in Fig. 4 are used to prevent the screws from loosening up when the die is in operation.

Fig. 5 shows the upper half of the die used for producing the field and pole punchings. In this illustration the outside die ring, the solid stripper, the knockouts, and the templets for the sections of the punch are clearly shown. The punch is composed of one each of sections T, U, V and W and two of section X. These sections are doweled onto a tool steel plate Y, the plate and 1/8 inch at the bottom of the sections being ground on the outside to fit a circular recess

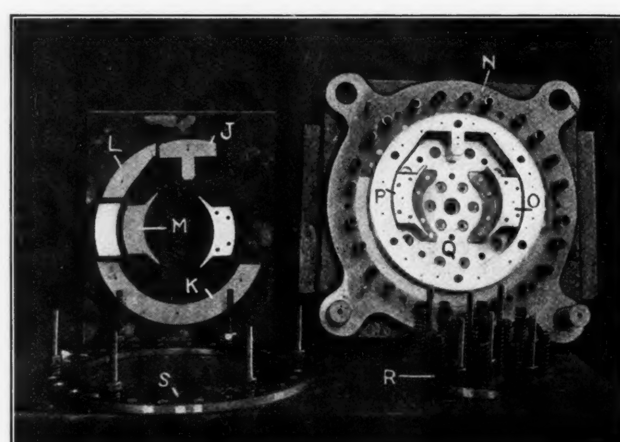


Fig. 4. Lower Half of Die with Strippers removed; also Templets for the Punch Sections

in the holder Z, to which the plate is held by dowel pins and fillister-head screws. The solid stripper a is made of tool steel with two hardened dovetailed sections inserted. These sections sever the pole punchings from the field at the points marked I in Fig. 1. The springs shown in the die-holder Z, Fig. 5, take the thrust of the cut, and as the pole punches are 1/8 inch higher than the field punches—as previously explained—the pole punchings are blanked before the field punchings. The stripper serves as a support for the punches which pierce the small holes in the field, constitutes the cutting edge for the pole dies and also acts as an ejector for the field punching shown at A in Fig. 1. The die ring b is recessed into the holder Z; and the flange on the bottom of the stripper a, which fits into a recess in the blanking ring b, keeps the cutting edge flush with the rest of the die.

As a is ground to a close sliding fit with the inside of the die ring and the outside of the sectional pieces on the plate Y, perfect alignment is always maintained. The knock-outs c, for ejecting the pole punchings B and C in Fig. 1, are fastened to the bar d, which is worked automatically by the punch press.

All cutting members of this die are hardened and accurately ground so that there is absolutely no variation in the size of the blanks. A tolerance of 0.002 inch is allowed, but the dies are made to maintain the maximum size. The punches are made 0.003 inch smaller than the die, thus affording a cutting clearance of 0.0015 inch. A run of from 35,000 to 40,000 blanks is obtained between grindings, the number of pieces produced varying according to the grade of steel from which the work is being produced. Counting the three separate punchings produced at each stroke, this would mean a total production of from 105,000 to 120,000 finished blanks. The height of the punch and die above the holders is 1¾ inch. This affords 1⅜ inch of wearing surface, which corresponds to a total production of from 4,007,500 to 4,580,000 blanks, after which the strippers and flanges can be reduced

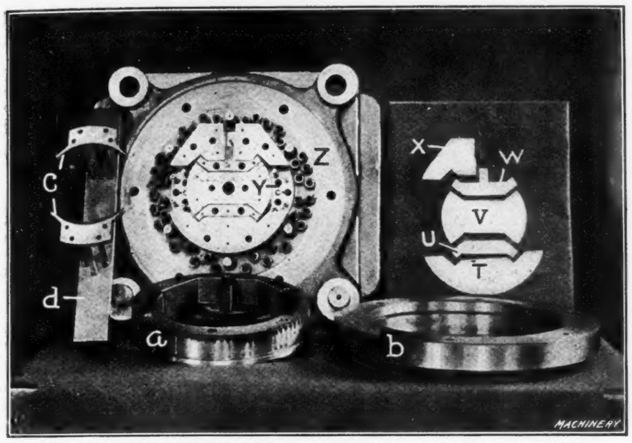


Fig. 5. Upper Half of Die, Solid Stripper, Outside Die Ring, and Templets for Sections

in thickness to give at least ⅛ inch more of wearing surface.

Fig. 6 shows the assembled die which is used for blanking and notching the armature disks, and also one of the finished disks and the scrap left in making it. It will be seen that the disks are produced from the scrap formed by the die used for making the field and pole punchings, this scrap being shown at D in Fig. 1. The blank for the armature disk is located on the die by means of a nest of spring pins which are shown at e in Fig. 6. The spring stripper plate is recessed to allow the operator to handle the blanks quickly with a pair of pliers. Fig. 8 shows the die taken apart, the lower half being shown at the right-hand side of the illustration. This part of the die is made up of sections having a flange on the bottom, the design of one section being shown in detail in Fig. 9. These sections are accurately fitted together and built around a tool steel plug which is bushed to receive the center hole and keyway die. The assembled sections are fitted into a recess in a tool steel plate and securely fastened by means of screws and dowel pins. The plate itself is held in a recess in the die-holder f, and the scrap from the center hole goes down through the die.

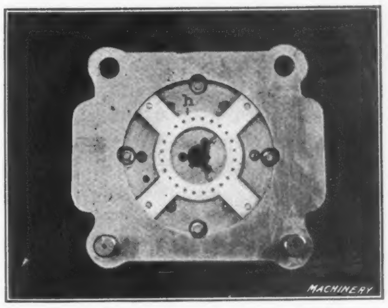


Fig. 7. Back of Lower Half of Die showing Method of securing Strippers

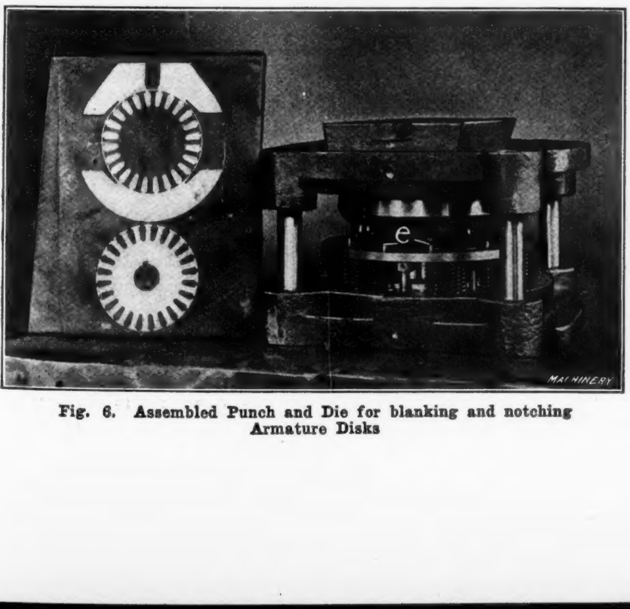


Fig. 6. Assembled Punch and Die for blanking and notching Armature Disks

The part marked g is a spring stripper plate; the strippers for the slots are made separate and they are a close sliding fit in the slots, thus helping to support the die sections. Studs threaded on one end are screwed into the bottom of the strippers and the opposite ends of these studs pass through the die-holder and are secured in the ring shown at h in Fig. 7. This ring is fastened to the stripper plate g (Fig. 8) by means of four flat-headed screws and the springs under the plate g operate all of the strippers. One of the punches for the upper part of the die, shown at the left-hand side in Fig. 8, is illustrated in detail in Fig. 10. These punches have a flange on the bottom and are accurately fitted together at the correct angle to obtain accurate spacing and alignment with the lower die sections. The punches are assembled on a tool steel plate and ground on the outside to a snug fit in a tool steel ring which constitutes the cutting edge for the outside diameter of the blank. The knock-out i in Fig. 8 is ½ inch thick; it is made a sliding fit on the slot punches and is connected by three studs to a plate in the head block. This knock-out is worked automatically by the press. The punch for making the keyway is dovetailed into the center hole punch j, the shank of which is made a driving fit in the holder k. The sections of these dies are milled to size so that no filing or fitting is necessary after the parts have left the milling machine. The final finish is obtained by grinding between the joints and this grinding is only necessary when the steel has expanded in the hardening process, the expansion never amounting to

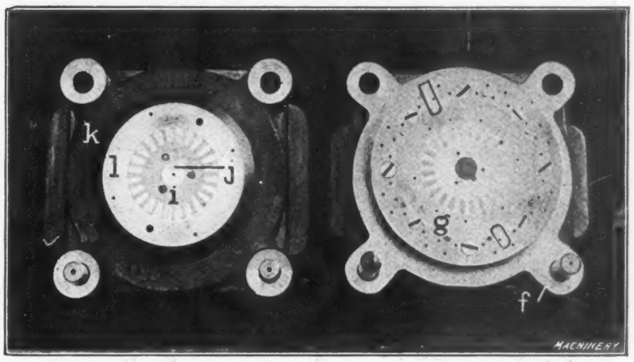
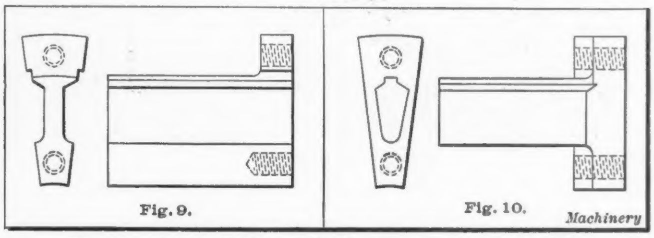


Fig. 8. Upper and Lower Halves of Die shown in Fig. 6

more than from 0.001 to 0.002 inch. The outside cutting edge of the die sections is ground to the correct diameter to give a clearance of 0.0015 inch between them and the ring l in Fig. 8. The center die and punch and the ring l are ground all over, the punches being 0.0015 inch smaller than the dies. The center die j has a tapered hole through it which allows the scrap to drop down.



Figs. 9 and 10. Design of Sections for the Punch and Die shown in Fig. 8

The average number of pieces produced in this die between grindings is 35,000 and at least 1½ inch of the die can be used up. This corresponds to a total production of 4,375,000 blanks. This number of blanks produced from

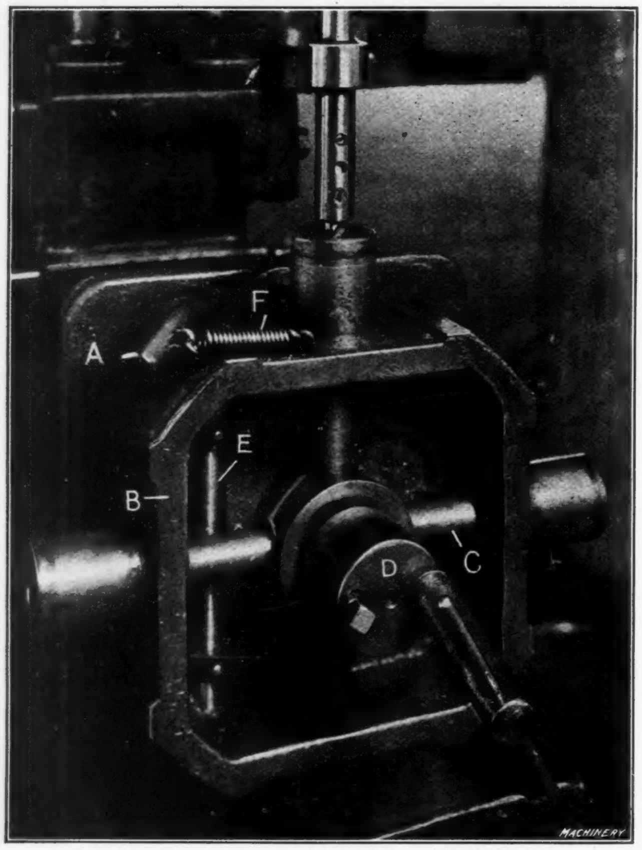
sectional dies is not unusual and we have some dies that have stood up under this rate of production without requiring any repairs during a period of three or four years. The stock used is Crucible Steel Co.'s 1.25 per cent carbon steel which is hardened so that it cannot be scratched with a file. The first cost of the sectional dies is considered by many to be higher than that of solid dies, but in the opinion of the writer, considering the life of the dies, they are cheaper in the end, providing the number of parts to be produced is large enough to warrant the increase in first cost.

* * *

INDEXING JIG FOR COUNTERSINKING DIFFERENTIAL SPIDER ARMS

The ordinary way of making a differential spider is to center the ends of the arms, rough-turn the forgings, harden the spider and grind the arms to the finished size. The Brown-Lipe-Chapin Co. of Syracuse, N. Y., has a better way, however, of finishing the spider. The forging is chucked and rough-turned, including the arms and then, without centering the ends of the arms, the piece is casehardened as it is. A row of hardened spiders is then strung on an arbor and sufficient metal is ground from the ends of the arms to remove the hardened case. This leaves the soft cores exposed for center drilling. By drilling after hardening a better working center is obtained, and one that is not full of scale; moreover the centers are not influenced by any distortion that might occur in hardening.

The jig upon which the center drilling is done is of more than ordinary interest. As shown in the illustration, it consists of the angle-iron base *A*, upon which is swiveled the jig section *B*. The spider, which is indicated at *C*, is slipped over the swiveling stud *D*. In order to locate the spider centrally in the jig, that is, so that the arms will come in average alignment with the four bushings, the centering dog *E* is employed.



Indexing Jig for countersinking Differential Spider Arms

By means of a spring *F*, whose end is attached to the bent end of the dog, the two aligning fingers are brought to bear simultaneously against opposite arms of the spider. Thus the spider is located evenly in the jig. After this it is a simple matter to drill and countersink the spider arms one after another, indexing the jig by hand for each arm.

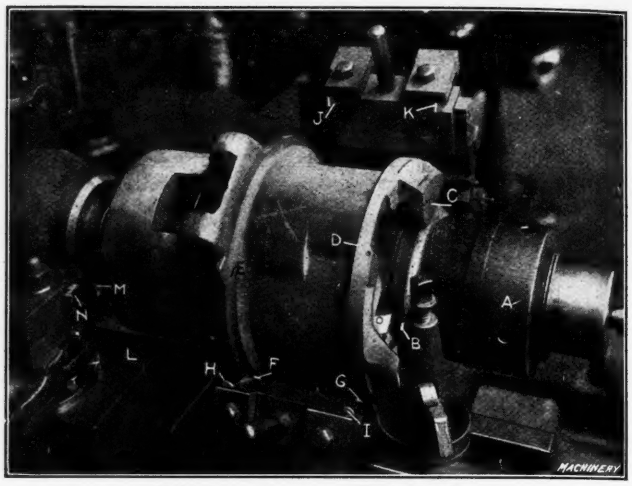
An idea of the facility with which this jig is operated can be gathered from the fact that five hundred of these spiders are drilled and countersunk in a day of nine hours, making a total of two thousand holes per day. The most important part, however, is the fact that the method insures that the centering is done with reference to the *hardened* spider arms, thus insuring that the amount of metal removed in grinding will be practically equal at all points.

C. L. L.

* * *

A MULTIPLE TURNING JOB ON AN ENGINE LATHE

Given an old engine lathe, almost ready for the scrap heap as far as general work is concerned, and a very accurate turning job, one would hardly expect to see the two combined harmoniously. Yet this combination was effectively accomplished at the Ritter Dental Mfg. Co.'s factory in Rochester, N. Y.



Multiple-turning on an Engine Lathe

The turning job was the machining of a cylinder for the base of a dental chair, an operation that consumed a great deal of time when done by ordinary turning methods, and it was desired to make a special turning fixture for the work. The illustration accompanying this article shows how the cylinder casting was held on the expansion arbor *A*, which in turn was held on the centers of the lathe. The only change required in the lathe was to make sure that the spindle had no shake and that it would turn straight, and also to put on the special carriage attachments shown. A facing tool *B* is held in the toolpost of the lathe and used for facing the ends of the base. The face that tool *B* machines is indicated at *C*. The most particular part of the work, that of facing off sections *D* and *E*, is well handled by special tooling on a separate carriage with which the lathe is fitted. As each of these sections is only approximately ½ inch wide, by using the two special roughing tools *F* and *G* mounted in fixed positions, only a very short travel of the carriage is required.

After these two surfaces were roughed they were semi-finished by the two tools *H* and *I*. These tools are on a separate swinging latch that the operator swings up to a stop and allows to make the cut. This leaves the two surfaces in a semi-finished condition and the final light chip is taken by tools *J* and *K* on a similar latch block at the top, mounted at the reverse side of the carriage. The latch mechanism that holds the tool-block down while making the cut may be seen at the side of the upper left block. While these cuts are taking place, the operator uses the special auxiliary slide *L* on the carriage, on which are mounted tools *M* and *N*. Tool *M* is a boring tool for facing out a small section within the casting, and tool *N* is a chamfering tool that serves to face and round the corner of this end of the casting.

The limit on this job is 0.002 inch on all measurements. The production is eighty-five cylinder bases in eight and one-half hours. Owing to the complication of the tool set-up, the lathe is kept set ready for this job at all times. Instead of being sent to the scrap heap it has been made an effective machine for this job.

C. L. L.

BULLDOZER DIES FOR FORMING STEEL STIRRUPS

BY P. P. FENAUX*

In certain of its products, the General Electric Co. uses steel stirrups of the form shown in Fig. 1. These stirrups are made of high carbon steel of approximately 3/4 by 3/8 inch in cross-section. As the quantity of these parts that are required is rather large and as no forging machine was available, it was decided to makes dies in which these stirrups could be produced on a standard bulldozer. As the dimensions are required to be within 1/64 inch of uniform, it was necessary to make dies that would produce work within these limits without requiring any subsequent forging which would leave hammer marks.

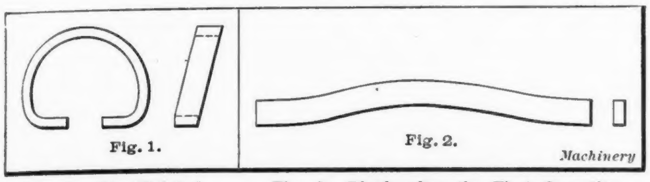


Fig. 1. The Finished Stirrup

Fig. 2. Blank after the First Operation has been performed

The sequence of operations involved in making these stirrups is as follows: A bar of steel is sheared into blanks of the required size, which are first bent to the form shown in detail in Fig. 2, this form being a development of the finished stirrup. Suitable allowance is made for the spring of the steel in order to obtain the required dimensions. The blanks are bent to the form shown in Fig. 2 between the dies *A* and *B*, which are shown in the operating position, and also in cross-section in order to illustrate the construction more clearly. The die *A* is fastened to the stationary base *C*, which is, in turn, bolted to the ways of the bulldozer and backed up by adjusting screws *D*. It will be seen that the plates *A* and *B* overlap in order to prevent distortion of the work while it is being bent into shape. The die *B* is bolted to a supporting plate *E* which is carried by a second plate *F* bolted to the ram of the bulldozer. The gage *G* provides for locating the blanks in the proper position.

The next step is to complete bending the work to bring it to the form shown in Fig. 1. When the ram recedes after performing the preliminary operation between the dies *A* and *B*, the work is taken out and laid edgewise on the shelves *H* and *J* of die *K*. The gage *X* provides for locating the work in the required position. When the ram comes forward, it pushes the wedge *L* against the slide *M* which travels on ways provided in the block *N*. During the first part of the operation performed in this die, the block *N* is held stationary by a locking-pin; but after the slide *M* has completed its travel, the locking-pin is released and the block *N* moves forward. A more complete explanation of this part of the work will be given in a subsequent paragraph. The slide *M* carries a form *P*, and as the slide moves to the right this form comes into contact with the work and forces it into the die *K*, thus bending the piece to a U-shape.

When the operation has proceeded to this point, the wedge *Q* located on the under side of the base *C* pulls out the locking-pin *R*, thus leaving the block *N* free to move. As the ram continues its forward movement, the die *S*, which is fastened to the ram, comes into contact with one arm of the U-shaped piece on the form *P* and bends it around the form. At the same time the ram continues to move forward and pushes the slide *M* and the block *N* with it. In so doing, the other arm of the U-shaped work is pushed into the stationary die *T*, which bends it around the form *P*. At the end of the forward movement of the ram, both the dies *S* and *T* come in contact with the wedge-shaped end of the slide *M*, which forces the dies against the form *P*, thus setting the work onto the form. The dies *S* and *T* are pivoted at the points *V* and *W*, respectively, to enable the dies to be moved by the tapered surfaces on the slide *M*. While this forming operation is being performed, the work is pushed against a stamping device *Y* set in the die *K*, which produces the necessary marking on the part. When the ram returns, the die is released and the slide *M* is pushed back by the springs in the block *N*; then the link A_1 draws the block *N* back, the pin B_1 being provided in the block for this purpose.

The form *P* is now taken out of the slide with the work in place around it. The third operation consists of setting the work in the dies C_1 and D_1. The purpose of this operation is to overcome the elastic limit of the material so that the piece will be set to exactly the required form. After this final operation has been completed, the form is pushed out of the work by means of the ejecting-pin E_1, leaving it in the shape shown in Fig. 1.

* Address: 143 Bellevue Road, Lynn, Mass.

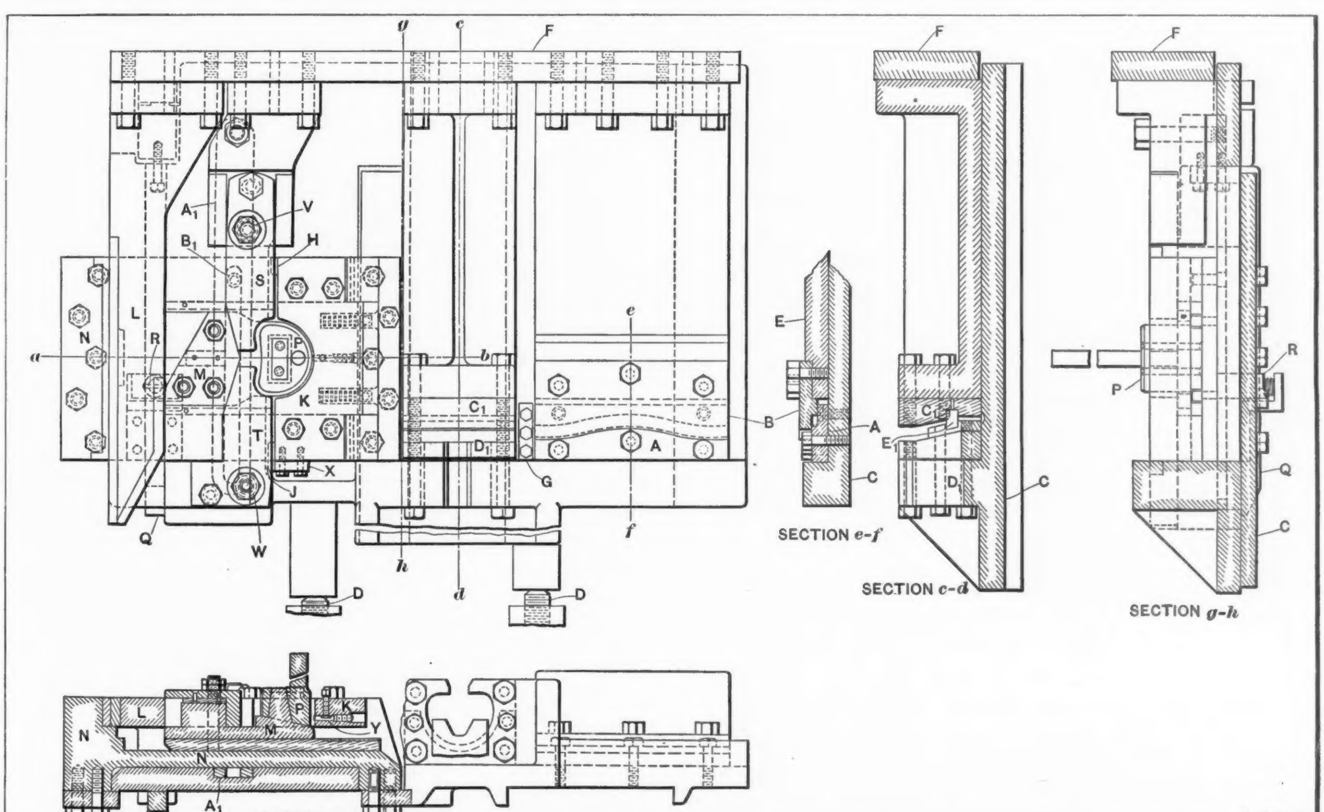
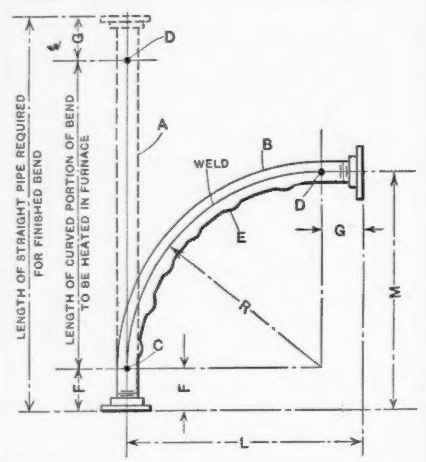


Fig. 3. An Interesting Set of Bulldozer Dies for forming Stirrups of the Form shown in Fig. 1

STEAM POWER PLANT PIPING DETAILS—9*

THE DESIGN OF WROUGHT IRON AND STEEL PIPE BENDS

BY WILLIAM F. FISCHER†



Length of straight pipe required = F + 1.57 R + G.

Machinery

Fig. 68. A 90-degree Bend and the Straight Pipe required to make it

IN a previous number of MACHINERY rules, tables and formulas were given for estimating the amount of expansion cared for by expansion bends of different types. In this installment, rules and formulas will be given for the design of wrought iron and steel pipe bends in general. When used to convey steam at high pressure, wrought iron and steel pipe bends 4 inches and over in size are usually made up with "rolled" or Van Stone joints, or in some cases the flanges are welded direct to the pipe. In making rolled or Van Stone joints, the end of the pipe is heated in a furnace and then rolled over the face of the flange and finished off to a true bearing surface in a pipe lathe. When pipe bends are ordered with rolled, Van Stone, or welded flanges, it is always advisable to attach the flanges to the pipe and roll or finish the flange faces true in a pipe lathe before bending the pipe to the required form. Therefore it becomes necessary, in cases of this kind, to determine the length of straight pipe that will be required to make the bend to the given dimensions. After the length of the straight and curved portions of the bend have been determined by the designer, the general dimensions are noted on sketch sheets and sent to the pipe shop. A piece of pipe is cut to the proper length and the flanges attached and finished to a true bearing surface, after which the pipe is sent to the bender, who lays off on it the length of straight and curved portions of the bend (see Fig. 68) and places the pipe in the furnace to be heated to the proper bending temperature. The pipe is then removed from the furnace and placed on a bending table, where it is curved to the required dimensions.

In case the designer makes an error in calculating the length of straight pipe required for the finished bend, it will be readily understood that when the bend is made up and curved to shape it will be either too long or too short, as the case may be. Furthermore, unless the error is a slight one it may be impossible to make the bend to the desired dimensions without first cutting a new piece of pipe to the proper length, rolling or flanging new joints and finishing them true in a lathe. Errors of this kind are necessarily expensive and cause considerable delay in getting the piping material ready for erection. As a general rule, after the sketch sheets leave the drafting-room, an error in the length of straight pipe required for the finished bend is discovered only when the bend has been completed and is being checked up for dimensions on the bending table, in which case the material and workmanship represent a total loss to the manufacturer unless the bend can be used on some other job. For this reason, all calculations pertaining to pipe bends should be carefully checked in the drafting-room before the detail sheets are sent to the pipe shop. In the following article, the writer has prepared simple rules, tables and formulas which will enable the reader to determine all of the necessary dimensions required for pipe bends of the types illustrated below. These represent about all of the standard shaped bends ordinarily used in steam power plant work; therefore, the designer should be able to choose the type best suited to his purpose and figure the important dimensions accordingly. As a further guide in choosing the proper bend to use for a given service, the reader is referred to the second, third, sixth and eighth installments of this series, which appeared in earlier numbers of MACHINERY.

TABLE XIV. RADII FOR PIPE BENDS OF WROUGHT IRON AND STEEL PIPE*

Size of Pipe	Actual Outside Diameter of Pipe	Minimum Radius for Bends of Extra Heavy Pipe		Minimum Radius for Bends of Standard or Full Weight Type		Advisable Radius for Bends of Standard or Full Weight Type		Advisable Minimum Radius for Bends used to Take Care of Expansion and Contraction		Length of Straight required at Each End for Flange or Fitting	
Inches	Inches	Ft.	Ins.	Ft.	Ins.	Ft.	Ins.	Ft.	Ins.	Ft.	Ins.
1	1.315		2½		4		5		8		2½
1¼	1.660		3		5		6		10		2¾
1½	1.900		4		6		8	1	0		3
2	2.375		5		7		10	1	3		3½
2½	2.875		6		8	1	0	1	6		4
3	3.500		8		10	1	3	1	9		4½
3½	4.000		10	1	0	1	6	2	0		5
4	4.500	1	0	1	3	1	9	2	3		5½
4½	5.000	1	2	1	6	2	0	2	6		6
5	5.563	1	3	1	9	2	3	2	9		6½
6	6.625	1	9	2	0	2	6	3	3		7
7	7.625	2	0	2	3	2	9	3	9		8
8	8.625	2	3	2	9	3	3	4	3		9
9	9.625	2	9	3	3	3	9	4	9		10
10	10.75	3	3	3	9	4	3	5	6	1	0
11	11.75	3	9	4	3	4	9	6	0	1	1
12	12.75	4	3	4	9	5	3	6	6	1	2
14	14	5	6	6	0	6	6	7	6	1	4
15	15	6	0	6	6	7	0	8	6	1	5
16	16	6	6	7	0	7	6	9	0	1	6
18	18	7	3	7	9	8	3	.....		1	6
20	20	8	3	9	0	9	6	.....		1	6
22	22	9	3	.....		.....		.....		1	6
24	24	10	0	.....		.....		.....		1	6

Machinery

* Note.—Pipe 14 inches and larger is known as O. D. pipe, meaning outside diameter pipe.

Fig. 68 is a typical example of the method employed in laying off or marking straight pipe in the shop when used for bending purposes. The dotted lines *A* show the straight pipe flanged and marked, ready for the bender; and the full lines show the completed bend, true to dimensions. Take, for example, a 6-inch 90-degree bend of the form shown in Figs. 68 and 69, to be made to minimum dimensions *L* and *M*, using extra strong or extra heavy pipe for the bend. By referring to Table XIV, we find the minimum radius *R* for a 6-inch bend of extra strong pipe is 1 foot 9 inches or 21 inches; and the minimum length of the straight sections *F* and *G* to be employed at each end of the bend is 7 inches, making minimum dimensions *L* and *M* in Fig. 68, 1 foot 9 inches +

* The eighth installment of this series was published in the May number of MACHINERY.

† Address: 3959 Fulton Ave., Woodhaven, L. I., N. Y.

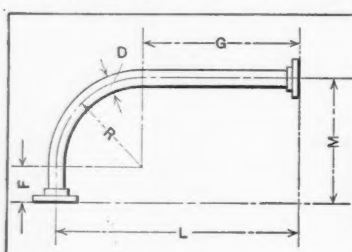


Fig. 69.

Length of straight pipe required = F + 1.57 R + G. Dimensions M, L, and R should be given when ordering the bend.

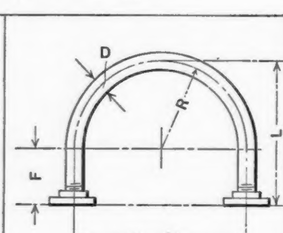


Fig. 70.

Length of straight pipe required = 2F + 3.14 R. Dimensions L, W and R should be given when ordering the bend.

Machinery

Figs. 69 and 70. A 90-degree or Square Bend and a U-bend

7 inches = 2 feet 4 inches from center to face. In Fig. 69, we find the length of the 90-degree circular arc = 1.57 × radius $R = 1.57 \times 21 = 32.97$ or say 33 inches. Therefore, the total length of straight pipe required for the finished bend = 33 + 7 + G = 40 + G inches or 3 feet 4 inches + G from face to face of the flanges. The length of the curved portion of bend (33 inches) is marked off, as indicated by the dotted lines in Fig. 68, and that portion of the pipe is heated in the furnace ready for bending. If no error has been made in calculating and laying off the dimensions on the straight pipe, the bend will be true to dimensions when curved to shape as indicated by the full lines.

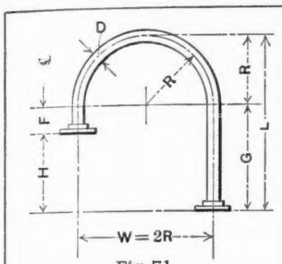


Fig. 71.

Length of straight pipe required=F+3.14 R+G. Dimensions L, W, H and R should be given when ordering the bend.

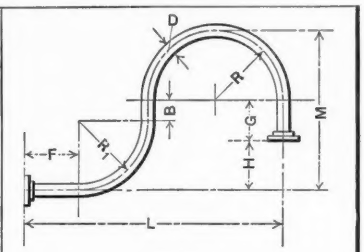


Fig. 72.

Length of straight pipe required = F + 1.57 R_1+B+3.14 R + G. Dimensions L, M, H, R and R_1 should be given when ordering the bend.

Machinery

Figs. 71 and 72. A Gooseneck U-bend and a Combination Square and U-bend

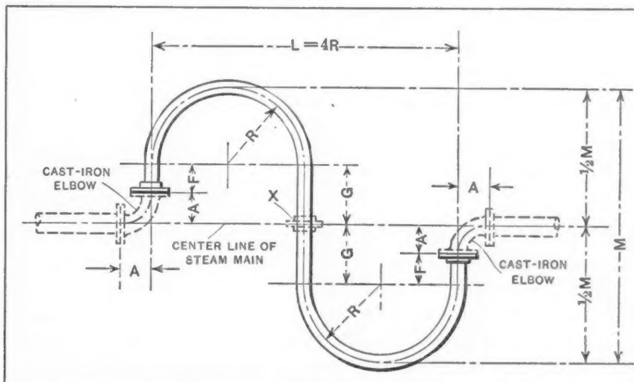
In order to prevent strains on the welded joint of the pipe when bending it to shape, the weld should be placed either up or down, *i.e.*, over the neutral axis of the pipe where it is neither in tension nor compression. The tension side of the bend is indicated by B and the compression side by E, Fig. 68, which also shows the proper position for the weld in bending. If the welded joint is placed either on the tension or compression side of the bend, the seam is very likely to spread or open up, due to the severe bending strains at these points. If the radius R is made less than the values indicated in the third and fourth columns of Table XIV, the pipe is likely to buckle on the compression side of the bend, as shown at E; and it will assume an oval shape in cross-section at these points, thus decreasing the effective area and destroying the general appearance of the bend. Pipe bends curved to a very large radius are also likely to buckle on the compression side of the bend, due to the bender having to take short heats, *i.e.*, heat the pipe two or more times in order to complete the curve. Lap welded wrought iron or steel pipe is to be preferred to butt welded pipe for bending purposes, as the weld is more secure and less likely to spread or open up when bending.

Pipe Bends with Screwed Joints

Although pipe bends having threaded ends and screwed flanges may be cut, threaded, and flanged after bending, it is rather difficult to perform this work satisfactorily by machine, especially if the pipe is of large diameter. In all cases, it is advisable to flange the pipe and finish the flanges true in a lathe before bending to the desired shape. Pipe bends having threaded ends and screwed flanges are frequently made up as "fillers" or closing pieces; these bends are made with long ends, which are cut off by the steam fitter to suit the closing dimensions of the line. In a case of this kind it is, of course, necessary to cut, thread and flange the pipe in the field after the bend is made. In all cases where bends can be made to correct dimensions in the shop, however, much time and expense can be saved by cutting, threading and flanging the pipe before it is curved to shape on the bending table.

Minimum Standard and Maximum Radii for Pipe Bends

Steel or wrought iron pipe bends made up of "standard" or "full weight" pipe (*i.e.*, standard weight pipe not under 5 per cent of card weight, as listed in the manufacturers' catalogues) should not be bent or curved to a radius less than that listed in the fourth column of Table XIV, as these are considered the minimum safe radii to employ for standard light weight pipe, when perfect bends are desired. Although it is possible to bend standard weight pipe to a smaller radius than listed in this table, it is not advisable to do so, owing to the danger of the pipe buckling on the compression side of the bend, as shown in Fig. 68. When bends of a shorter radius are desired, they should be made of extra strong or extra heavy pipe, having approximately twice the thickness of a standard or full weight pipe of the same outside diameter. The dimensions in the third column of the table are the minimum radii to be employed for pipe bends of extra strong pipe. In the fifth column of the table is given the advisable radii to use for bends of standard or full weight pipe. In the sixth column of the table is given the advisable minimum radius to employ for bends which are to be used as expansion bends for relieving the expansion and contraction strains in a long line of piping, as explained in an earlier number of MACHINERY. In this respect, it should be understood that any increase in the radius of an expansion bend adds considerably to its flexibility (see the eighth installment of this series published in the May number).



Length of straight pipe required, if made in one piece without flanges at X = 2F + 2G + 2 x 3.14 R. Dimensions F, G and R should be given when ordering the bend.

Machinery

Fig. 75. Special S-type of Expansion Bend

The maximum radius of curvature for a pipe bend of any description is governed by the character of the bend, the length of pipe required to make the bend to the given dimensions, and the space available for erection, rather than by the design of the bend. If the radius of the bend is too large, however, the bender may find it necessary to take more than one heat for each circular arc, in which case there is always more or less danger of the pipe buckling on the compression side, as previously mentioned. The minimum length of straight pipe to be allowed at

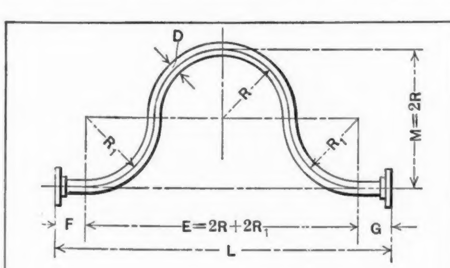


Fig. 73.

Length of straight pipe required=F + 3.14 R_1+ 3.14 R+G. Dimensions L, M, R and R_1 should be given when ordering the bend.

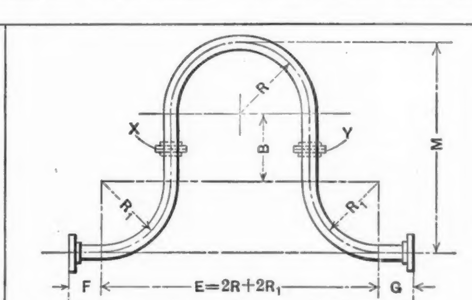
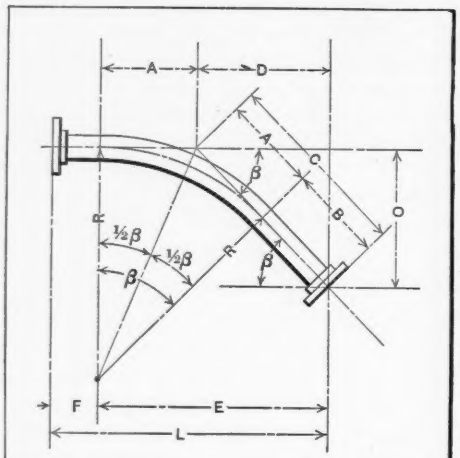


Fig. 74.

Length of straight pipe required=F + 3.14 R_1+ 2B+3.14 R+G. Dimensions L, M, R and R_1 should be given when ordering the bend.

Machinery

Figs. 73 and 74. Expansion Bends with and without Straight Sections between the Arcs



Length of straight pipe required $= F + 0.01745\ R\beta + B$. Dimensions L, O, R and angle β should be given when ordering the bend. $A = R \times \tan \frac{1}{2}\beta$, $D = O \times \cot \beta$ and $E = A + D$. Then $F = L - E$, $C = O \div \sin \beta$ and $B = C - A$. The length of the circular arc of angle $\beta = 0.01745\ R\beta$.

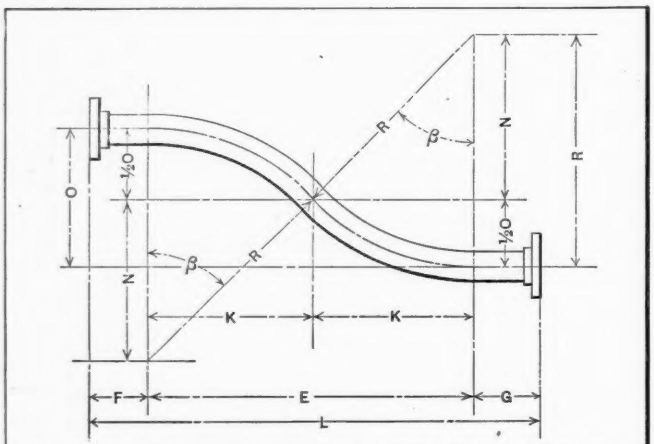
Machinery

Fig. 76. Angle Bend

each end of a bend for the attachment of flanges, or to screw into pipe fittings, is given in the last column of Table XIV. If the length of straight pipe at each end of a bend is made less than given in the table, there is always more or less danger of the pipe flattening or assuming an oval shape at the end while it is being bent, especially on bends of short radius, in which case there is danger of leakage occurring between the body of the pipe and the flange. The dimensions listed in Table XIV are a fair average of those recommended by several of the large manufacturers making a specialty of pipe bending, and may be considered safe figures to work to in all cases.

Rules and Formulas for Determining the Dimensions of Pipe Bends

The 90-degree or square bend illustrated in Fig. 69 is probably the most common type in use today. Bends of this kind are frequently used in place of 90-degree elbows, wherever it is required to take branches off at right angles to the main header. The U-bend shown in Fig. 70 may be used either as a return bend or a cross-over bend between two headers or



Length of straight pipe required $= F + 2 \times 0.01745\ R\beta + G$. Dimensions L, F, O and R should be given when ordering the bend. $N = R - \frac{1}{2}O$ and $\cos \beta = \frac{N}{R}$, from which the angle β is obtained. $K = N \times \tan \beta$ and $E = 2K$. Then $G = L - (E + F)$. The length of each circular arc of angle $\beta = 0.01745\ R\beta$.

Machinery

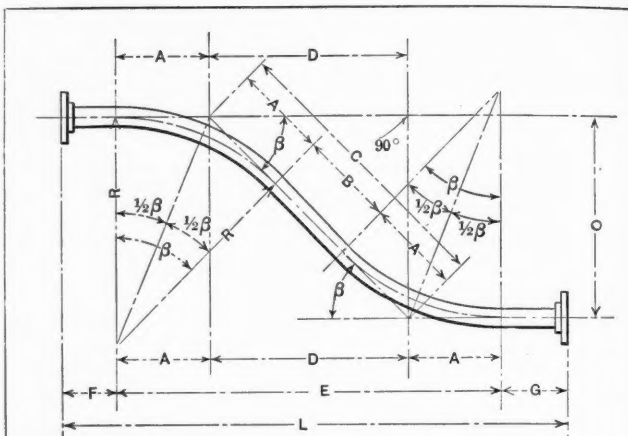
Fig. 77. Offset Bend with no Straight Section between the Arcs

mains; or it may be used in connection with two 90-degree bends or elbows as an expansion bend, similar to the arrangement shown in Fig. 74. The gooseneck U-bend illustrated in Fig. 71 is similar in all respects to the U-bend in Fig. 70, except that one leg of the bend is longer than the other, offsetting the flanges as shown at *H*. The bend shown in Fig. 72 is a combination of a U-bend (Fig. 70) and a 90-degree or square bend (Fig. 69). The expansion bends shown in Figs. 73, 74 and 75, as the name implies, are used for the purpose of taking up or relieving the expansion and contraction strains in a system of steam piping, as described. The length of straight pipe required to make any of the bends illustrated in Figs. 69 to 75, inclusive, may be found by adding together the length of the straight and curved portions of the bend, as described for each case. As these bends are either curved to an arc of 90 or 180 degrees, or to a combination of the two, it is a very simple matter to determine the dimensions indicated on the drawings. The length of each circular arc is readily determined as follows:

Length of 90-degree circular arc $= 1.57\ R$.

Length of 180-degree circular arc $= 3.1416\ R$.

Owing to the long length of pipe required to make the finished bends illustrated in Figs. 74 and 75 in one piece, it may be necessary—especially in the larger sizes—to make these bends in two or more pieces by adding the flanges as shown dotted at *X* and *Y*. Standard steel and wrought iron pipe may be obtained from the mills in random lengths up to 22 feet, and special welded pipe, for bending purposes, in lengths up to 40 feet. Lengths up to 22 feet are usually kept in stock, but if longer lengths are required they may have to be ordered, in which case it may be necessary to wait some time for delivery. Most of the larger manufacturers of piping materials are equipped with welding outfits and make a practice of welding pipe in suitable lengths for especially



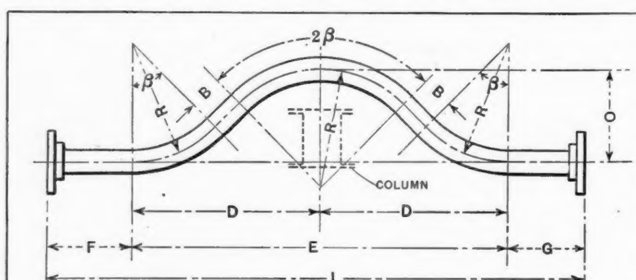
Length of straight pipe required $= F + 2 \times 0.01745\ R\beta + B + G$. Dimensions L, F, O, R and angle β should be given when ordering the bend. $A = R \times \tan \frac{1}{2}\beta$, $D = O \times \cot \beta$ and $E = 2A + D$. Then $G = L - E - F$. $C = O \div \sin \beta$ and $B = C - 2A$. Length of each circular arc of angle $\beta = 0.01745\ R\beta$.

Machinery

Fig. 78. Offset Bend with a Short Straight Section between the Arcs

long bends. In many cases, large bends made in one piece are no more expensive than those made in two or more pieces, as the cost of rolling the extra joints and attaching flanges will about even up in each case. In order to facilitate shipment and erection of the piping, however, it may be advisable to design the large bends so they can be made in two pieces if so desired.

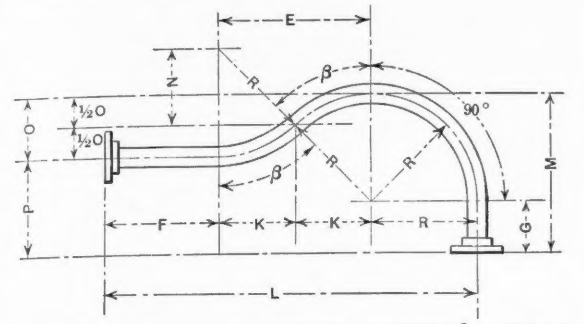
The bends illustrated in Figs. 76 to 84, inclusive, are more difficult to make and measure up than those illustrated in Figs. 69 to 75. The formula for figuring the length of straight pipe required for each type of bend under consideration is given under the illustration. The length of the circular arcs of angle β may be obtained as indicated for each particular case. For example, assume the angle β to be 45 degrees 50 minutes or 45 50/60 degrees, and radius *R* 4 feet 6 inches or 54 inches. Then, the length of the circular arc of angle $\beta = 0.01745 \times R \times$ angle $\beta = 0.01745 \times 54 \times 45\ 50/60 = 43.19$



Length of straight pipe required $= F + 4 \times 0.01745\ R\beta + 2B + G$. Dimensions L, F, O, R and angle β should be given when ordering the bend. The dimensions B and D may be obtained as explained in Fig. 78. Then $E = 2D$ and $G = L - F - E$. The length of each circular arc of angle $\beta = 0.01745\ R\beta$.

Machinery

Fig. 79. Double Offset or Cross-over Bend

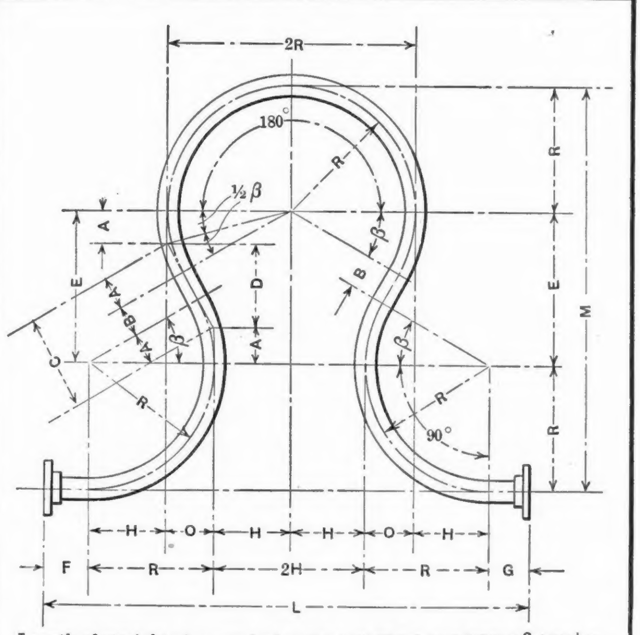


Length of straight pipe required $= F + 2 \times 0.01745\, R\beta + 1.57\, R + G$.
Dimensions L, R, P and G should be given when ordering the bend.
$M = G + R$, $O = M - P$ and $N = R - \frac{1}{2}O$. $\cos\beta = N \div R$, from which angle β may be obtained. $K = N \times \tan\beta$ and $E = 2K$. Then $F = L - E - R$.
Length of the 90-degree circular arc is 1.57 R and of each circular arc of angle β it is $0.01745\, R\beta$

Machinery

Fig. 80. Single Offset Quarter Bend without a Straight Section between the Arcs

inches = 43 3/16 inches. If the angle β were exactly 45 degrees, the length of circular arc of angle β would be $0.01745 \times 54 \times 45 = 42.4 = 42\ 3/8$ inches. The length of any circular arc can be found in a similar manner, and will be determined accurately enough for all practical purposes if angle β is read to degrees and the nearest minute in each particular case. That is, if angle β were actually 45 degrees 49 minutes 43 seconds, it would be close enough for all practical purposes to assume 45 degrees 50 minutes, or 45 50/60 degrees, expressed as a fraction. Having found the length of the curved portion, or portions, of the bend, it is only necessary to add the length of the straight portions in order to obtain the length of straight pipe (from face to face of flanges) required to make the bend.



Length of straight pipe required $= F + 4 \times 1.57\, R + 4 \times 0.01745\, R\beta + 2B + G$.
Dimensions L, M, F, G, R and angle β should be given when ordering the bend. $A = R \times \tan \frac{1}{2}\beta$, $D = O \times \cot\beta$ and $C = O \div \sin\beta$. Then $E = 2A + D$, $B = C - 2A$ and $H = R - O$. Length of each 90-degree circular arc is 1.57 R and of each of the circular arcs of angle β it is $0.01745\, R\beta$.

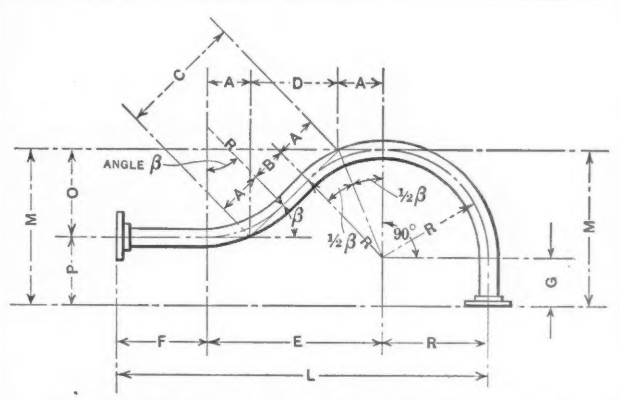
Machinery

Fig. 81. Double Offset Type of Expansion Bend

Examples Showing Method of Figuring Dimensions of Pipe Bends

As an example showing the method of figuring the dimensions of an angle bend, similar to that shown in Fig. 76, assume the following conditions: Size of pipe, 6 inches; radius R, 30 inches; distance L, 8 feet 6 inches = 102 inches; distance O, 3 feet, 4 inches = 40 inches; and angle β, 30 degrees 40 minutes.

Dimension $A = R \times \tan \frac{1}{2}\beta$. $\frac{1}{2}\beta = 15$ degrees 20 minutes and the tangent of $\frac{1}{2}\beta = 0.2742$. Therefore, dimension $A = R \times 0.2742 = 30 \times 0.2742 = 8.226$ inches. Dimension $D = O \times \cot\beta$. Cot 30 degrees 40 minutes = 1.6864 and $O = 40$ inches. Therefore $D = 40 \times 1.6864 = 67.456$ inches. Dimension $E = A + D = 8.226 + 67.456 = 75.68$ inches. Dimension $L = 102$ inches. Dimension $F = L - E$. Therefore, $F = 102 - 75.68 = 26.32$ inches = 26 5/16 inches. Dimension $C = O \div \sin\beta$. $O = 40$ inches, and sin 30 degrees 40 minutes = 0.51. Therefore $C = 40 \div 0.51 = 78.431$ inches. Dimension $B = C - A = 78.431 - 8.226 = 70.205$ or 70 3/16 inches. Length of circular arc β (curved portion of bend) $= 0.01745\, R\beta$. $R = 30$ inches and $\beta = 30$ degrees 40 minutes = 30 40/60 or 30 2/3 degrees. Therefore, the length of the circular arc of angle $\beta = 0.01745 \times 30 \times 30\ 2/3 = 16.054$ inches. Then the length of the straight pipe (from face to face of flanges) required for the finished bend = length of circular arc of angle $\beta + F + B = 16.054 + 26.32 + 70.205 = 112.579$ inches, or 9 feet 4 9/16 inches.



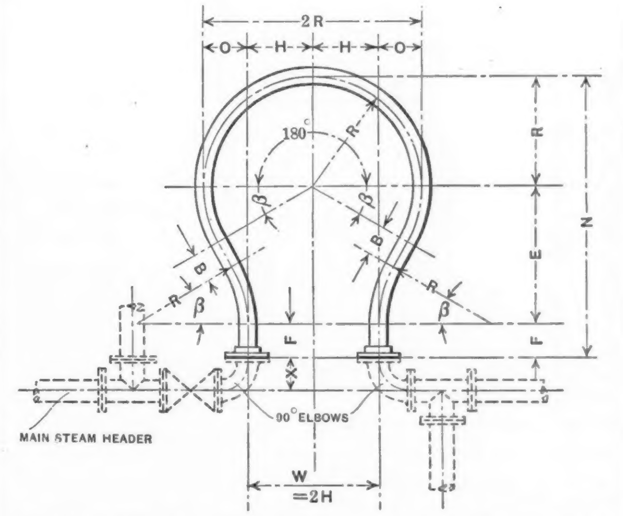
Length of straight pipe required $= F + 2 \times 0.01745\, R\beta + B + 1.57\, R + G$.
Dimensions L, P, G, R and angle β should be given when ordering the bend. $M = G + R$, $O = M - P$, $A = R \times \tan \frac{1}{2}\beta$, $D = O \times \cot\beta$ and $C = O \div \sin\beta$. Then $E = 2A + D$, $B = C - 2A$ and $F = L - E - R$. Length of the 90-degree circular arc is 1.57 R and of each of the circular arcs of angle β it is $0.01745\, R\beta$.

Machinery

Fig. 82. Single Offset Quarter Bend with Short Straight Section between the Arcs

Offset Bend with No Straight Section Between the Arcs

As an example showing the method of figuring the dimensions of an offset bend similar to that shown in Fig. 77, assume the following conditions: Full weight pipe 12 inches in size to be used. Given dimensions are G, F, O and R. The angle β is fixed by the specified offset O and radius R. It is required to make the dimension L as short as possible, using

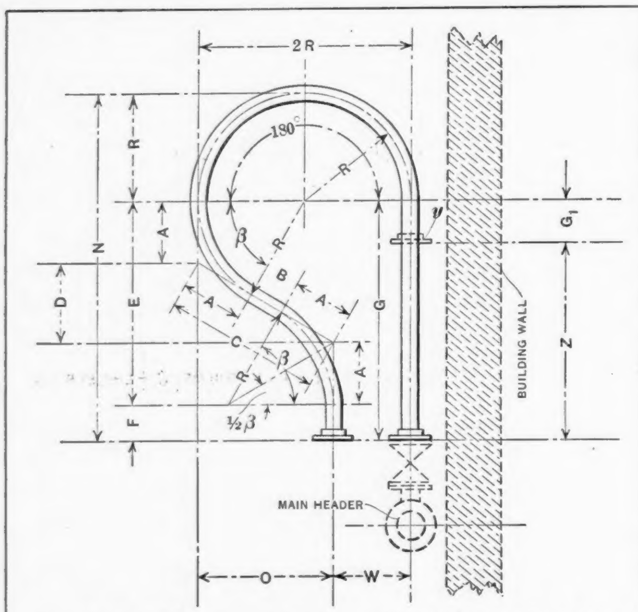


Length of straight pipe required $= 2F + 4 \times 0.01745\, R\beta + 2B + 2 \times 1.57\, R$.
Dimensions W, N, R, F and angle β should be given when ordering the bend. The dimensions O, B and E may be obtained as explained in Fig. 82. $H = R - O$. The length of each 90-degree circular arc is 1.57 R and of each circular arc of angle β it is $0.01745\, R\beta$.

Machinery

Fig. 83. Double Offset Type of U-bend

minimum dimensions for F, G, and R. Looking in Table XIV, in the fourth and last columns, and opposite 12-inch pipe we find the minimum radius R equals 4 feet 9 inches or 57 inches, and the minimum dimension for F and G equals 1 foot 2 inches or 14 inches. If we assume the offset O as $14\frac{3}{8}$ inches, $\frac{1}{2}$ $O = 7\ 3/16$ inches. Dimension $N = R - \frac{1}{2}\ O = 57 - 7\ 3/16 = 49\ 13/16$ or 49.8125 inches. $\cos\beta = N \div R = 49.8125 \div 57 = 0.8731$. From a table of natural trigonometric functions, we find that the cosine of 0.8731 corresponds to an angle of 29 degrees 11 minutes. Therefore angle $\beta = 29$ degrees 11 minutes. Dimension $K = N \times \tan\beta$. $N = 49.8125$ and tan 29 degrees 11 minutes $= 0.5585$. Therefore $K = 49.8125 \times 0.5585 = 27.82$ inches. Dimension $E = 2K = 2 \times 27.82 = 55.64$ inches. Therefore minimum dimension $L = F + E + G = 14 + 55.64 + 14 = 83.64$ inches $= 83\frac{5}{8}$ inches or 6 feet $11\frac{5}{8}$



Length of straight pipe required $= F + 2 \times 0.01745\ R\beta + B + 2 \times 1.57\ R + G$. Dimensions W, N, R, F and angle β should be given when ordering the bend. The dimensions O, B and E may be obtained as explained in Fig. 82. $G = E + F$. The length of each 90-degree circular arc is 1.57 R and of each circular arc of angle β it is 0.01745 $R\beta$.

Machinery

Fig. 84. Single Offset Type of U-bend

inches. The length of each circular arc of angle $\beta = 0.01745\ R\beta$, or length of both circular arcs (curved portion of bend) $= 2 \times 0.01745\ R\beta = 0.0349\ R\beta = 0.0349 \times 57 \times 29\ 11/60 = 58.054$ or 58 1/16 inches. Thus the length of the straight pipe (from face to face of the flanges) required for producing the finished bend $= 58\ 1/16 + 14 + 14 = 86\ 1/16$ inches or 7 feet 2 1/16 inches.

Offset Bend with Straight Between Arcs

As an example showing the method of computing the dimensions of an offset bend with a straight section between the arcs, as shown in Fig. 78, assume the following conditions: In this case L, F, O, R and the angle β are the given dimensions and should be determined by the designer when laying out the piping system to scale on the drawing board. Assume that a 6-inch pipe is to be used; $L = 9$ feet or 108 inches; $F = 18$ inches; $O = 42$ inches; $R = 36$ inches; and angle $\beta = 45$ degrees. Dimension $A = R \times \tan\frac{1}{2}\beta = R \times$ tan 22 degrees 30 minutes $= 36 \times 0.41421 = 14.91$ inches. Dimension $D = O \times \cot\beta = O \times$ cot 45 degrees $= 42 \times 1 = 42$ inches. Dimension $E = 2A + D = 2 \times 14.91 + 42 = 71.82$ inches. Dimension $G = L - (E + F) = 108 - (71.82 + 18) = 108 - 89.82 = 18.18$ or 18 3/16 inches (approximately). Dimension $C = O \div \sin\beta = O \div$ sin 45 degrees $= 42 \div 0.7071 = 59.40$ inches. Dimension $B = C - 2A = 59.40 - 29.82 = 29.58$ or 29 9/16 inches (approximately). The length of each circular arc of angle $\beta = 0.01745\ R\beta$, or the length of both circular arcs $= 2 \times 0.01745\ R\beta = 0.0349\ R\beta = 0.0349 \times 36 \times 45 = 56.538$ inches. The length of the straight pipe (from face to face of flanges) required for the finished bend = length of both circular arcs $+ F + B + G = 56.538 + 18 + 29.58 + 18.18 = 122.298$ or $122\frac{1}{4}$ inches $= 10$ feet $2\frac{1}{4}$ inches. The double offset bend shown in Fig. 79 is figured exactly the same as the above.

Double Offset Expansion Bend

As an example showing the method of computing the dimensions of a double offset expansion bend, as illustrated in Fig. 81, assume the use of an 8-inch pipe with the following given dimensions: Radius $R = 4$ feet 3 inches $= 51$ inches; angle $\beta = 30$ degrees; length of straight pipe between arcs at $B = 12$ inches; $F = 9$ inches; and $G = 9$ inches (see Table XIV). The other dimensions are to be computed as follows:

$A = R \times$ tangent $\frac{1}{2}\ \beta = 51 \times$ tangent 15 degrees $= 51 \times 0.26795 = 13.665$ inches; $C = 2A + B = 2 \times 13.665 + 12 = 39.33$ inches; $O = C \times \sin\beta = C \times$ sin 30 degrees $= 39.33 \times 0.5 = 19.665$ or $19\frac{5}{8}$ inches (approximately); $D = C \times$ cosin $\beta = C \times$ cosin 30 degrees $= 39.33 \times 0.866 = 34$ inches; $E = 2A + D = 2 \times 13.665 + 34 = 61.33 = 61\ 5/16$ inches or 5 feet 1 5/16 inch; $M = 2R + E = 2 \times 51 + 61\ 5/16 = 163\ 5/16$ inches, or 13 feet 7 5/16 inches; $H = R - O = 51 - 19\ 5/8 = 31\ 3/8$ inches, or 2 feet $7\frac{3}{8}$ inches; and $L = F + G + (2R) + (2H) = 9 + 9 + (2 \times 51) + (2 \times 31\frac{3}{8}) = 182\frac{3}{4}$ inches or 15 feet $2\frac{3}{4}$ inches. The length of each 90-degree circular arc $= 1.57\ R = 1.57 \times 51 = 80.1$ inches, or approximately 6 feet $8\frac{1}{8}$ inches. The length of the 180-degree circular arc $= 3.1416\ R = 3.1416 \times 51 = 160.2$ inches, or approximately 13 feet 4 3/16 inches. The length of each 15-degree circular arc of angle $\frac{1}{2}\beta = 0.01745 \times R \times \frac{1}{2}\beta = 0.01745 \times 51 \times 15 = 13.349$ or $13\frac{3}{8}$ inches (approximately). The length of each circular arc should be computed separately, as explained above, in order to mark off on the straight pipe the different lengths to be heated for bending. When computing the total length of straight pipe required for the finished bend, however, it is more accurate and more convenient to compute the curved portions of the bend as follows: Total length of the complete curved portions of bend $= (6.2832\ R) + (0.0698\ R\beta)$. Therefore, total length of straight pipe (from face to face of the flanges) required for finished bend $= (6.2832\ R) + (0.0698\ R\beta) + 2B + F + G = (6.2832 \times 51) + (0.0698 \times 51 \times 30) + (2 \times 12) + 9 + 9 = 320.44 + 106.80 + 24 + 9 + 9 = 469.24$ inches or 39 feet $1\frac{1}{4}$ inch.

When laying out the piping system to scale on a drawing board, the designer should fix the general dimensions of the pipe bends and take care of all clearances; that is, he should fix the governing dimensions of the bends so that proper clearance will be allowed between other members of the piping system, machinery, building walls, columns, etc.

* * *

IMPORTANCE OF STRONG BENCH VISES

The importance of providing bench vises heavy enough for the work to be done, thereby obviating loss of effect because of work being inadequately supported was forcibly brought out by an incident occurring in a Western Pennsylvania shop recently. A great deal of casehardening of small parts is done in this shop. The inspector customarily tests the work on an old vise by holding one of the pieces of the lot in the vise and striking it with a hammer in order to observe the depth of case. He recently used a much larger and heavier vise when testing a lot of casehardened parts and did not immediately consider the effect of the larger and heavier vise. He noticed that the piece struck by the hammer snapped off very easily, and for the time being assumed that the pieces were casehardened to a depth that made them brittle, but as the depth of case appeared to be normal he tried another piece with the same result. Then the thought occurred to him to employ the same conditions as formerly, and taking one to the old vise he found that it broke with the customary number of blows.

This little incident indicates again the well-known truth that a given blow has the greatest effect on work that is massive or massively supported. This holds true no matter what the work is—chipping, filing, etc. Workmen too often are inclined to think that a vise is a vise, overlooking the fact that weight and rigidity of vises are an extremely important factor in efficient bench work. Of course the vise must not be too heavy and too cumbersome for light work, but in all cases it should be chosen with due regard to weight and strength as compared with the work to be done.

POWER PRESS GUARDS*

A VARIETY OF DEVICES FOR PROTECTING THE OPERATOR FROM BEING INJURED

BY MANCIUS S. HUTTON†

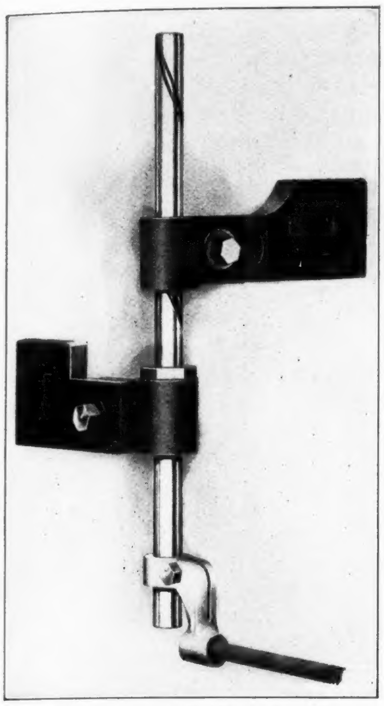


Fig. 1. Hemphill "Push Guard"

In discussing the subjects of safeguards for power presses all machines will be considered on which punching, embossing and stamping is done, both in the large and small sizes. There are two classes of power presses: first, those in which the piece is fed mechanically under the descending ram; and second, those which must have the metal placed in position by hand. Very few accidents happen to employes operating presses of the former class, but in the case of the latter, a large number of operators have their fingers crushed or sheared off by the descending ram. There are four types of mechanical feeds for primary operations and four for secondary operations, any of which is absolutely safe provided the press is stopped at the end of each stroke. A primary operation is one that is done by the machine upon merchant stock in the form of a sheet or bar, and which gives a shape or form to such stock. The secondary operations are done upon this shaped or formed blank.

There are two means of throwing the clutch into mesh to cause the ram to descend: first, by the operator pressing his foot on a treadle; second, by the operator moving a lever with one or both of his hands. To prevent power press accidents, the hands of the operator should be kept from under the ram when it descends by means of safeguards put on the machines for this purpose. There are four methods by which this can be done. First: by having a guard which pushes the hand away before the ram descends. Second: by having a device which prevents the clutch being thrown, locking the ram in its upper position while the operator's hands are under the ram but releasing it when the hands are removed. Third: by having a guard entirely surrounding the danger zone. Fourth: by requiring both hands to be used to operate the machine. The machines which are operated by the foot will require guards of the first, second or third classes, as the hands will be free to get in the way of the descending ram. A machine so designed as to require the use of both hands to operate it is a safety device in itself; but if only one hand is required, then it would be advisable to adopt one of the other three methods.

Foot Operated Machines

To prevent the occurrence of accidents, it is essential that the persons who operate power presses should not have their minds diverted from the work in hand. It is a fact that the continual working of the foot treadle by the operators, and the feeding of pieces with the hands soon becomes second nature. The result is that they acquire a certain automatic rhythmic movement which is likely to prove disastrous, should a mental disturbance of the rhythm be caused by a sudden noise or movement in the vicinity of the operators, or a desire on their part to look around at something happening near them. It might be safely said that practically all power press accidents occurring on this type of machines, in which the operator has one or more fingers crushed, are due to his mind being diverted for the instant, causing him to forget to take the fingers away from the point of danger before the treadle is depressed and the ram descends.

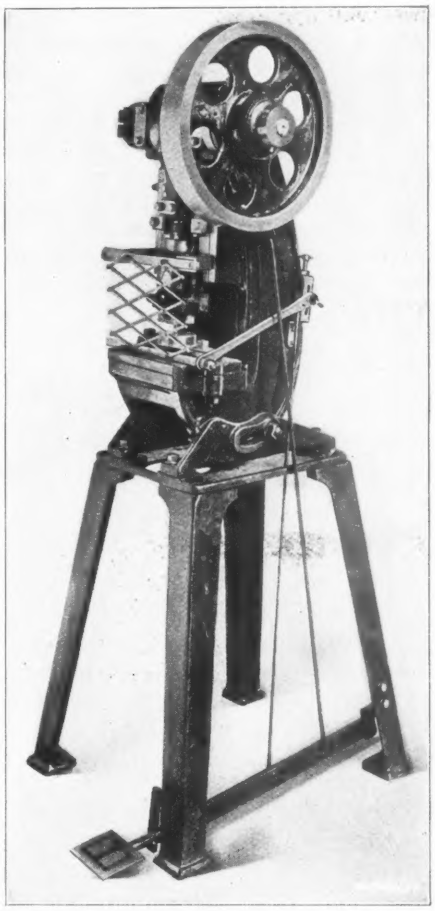


Fig. 3. Geuder, Paeschke & Frey "Lock" Type of Guard

In operating these machines, the ram should be allowed to come to a full stop in its upper position before the treadle is depressed again. In piece work it often happens that the operators do not take time to allow this to be done; and to remedy this condition, several of the press makers have a device by which the clutch lever detaches itself from the treadle action each time the latter is depressed, by means of a cam upon the main shaft which, itself, performs the stopping action of the clutch. Accidents are sometimes caused by the clutch getting out of order or by the flywheel seizing due to improper lubrication, thus causing the ram to descend when it is least expected. Where small objects are required to be formed or repunched, necessitating placing them between the dies, they should be inserted and removed with a stick of pine wood instead of the fingers.

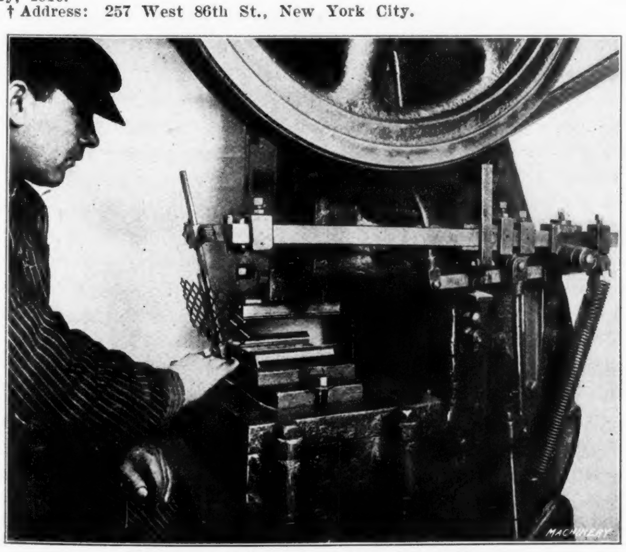


Fig. 2. A Safeguard of the "Lock" Type

* For additional information on the safeguarding of power presses and allied subjects published in MACHINERY see also "Safeguards for Power Presses," by Edward K. Hammond, November, 1912; "A Mechanically and Electrically Operated Safety Device," by Benjamin C. Waite, July, 1912; "Prevention of Industrial Accidents," by F. R. Hutton, April, 1912; "Accidents in the Machine Shop," November, 1911; "Safety Device as Applied to Machine Tools," by Clarence Bolton, November, 1911; "The Prevention of Industrial Accidents," November, 1911; "The Mechanical Engineer and Prevention of Accidents," March, 1911; and "Practical Safeguards in the National Cash Register Co.'s Plant," by Ethan Viall, January, 1910.

† Address: 257 West 86th St., New York City.

It sometimes happens that an operator places a piece in the die in the wrong position, and then at the moment of depressing the treadle with the foot he discovers his mistake. An accident will occur if he attempts to remedy the mistake with his hands at the moment of discovery. This is not an unusual thing to occur in a machine shop. If the fingers are required to be under the ram while doing repair work or in changing the dies on the machine, a block of wood or metal should be placed in such a manner that the ram will be unable to descend if the treadle is depressed accidentally. The same thing should be done in case the clutch gets out of order or the flywheel seizes. The gears on the front of the presses should be enclosed with metal guards and the belting should also be covered. These guards are especially needed on machines which are operated by women, in which case there is a possibility of their hair being caught.

Push Guards

The guards in this class push the hand of the operator away from the danger zone before the clutch engages the flywheel and causes the ram to descend. One of the first of this type of guards to be put on the market is that shown in Fig. 1, which is made by A. J. Hemphill & Co., 11 Broadway, New York City. From the illustration it will be seen that the hands of the operator are forced away from the danger zone by a radial arm, which swings across the face of the lower die as the ram is descending. This arm is actuated by means of a nut which fits in a helical groove in the upright at the left-hand side of the machine. Another guard which belongs to this class but which works on a little different principle is that illustrated in Fig. 4. This guard is made by the H. & A. Lock Co., 156 Fifty-third St., Brooklyn, N. Y. It consists of a metal plate which lies flat on the bed plate of the press when the ram is in its upper position, but which swings outward and upward toward the operator by means of a bell-crank operated by the treadle, throwing his hand away from danger before the clutch becomes engaged.

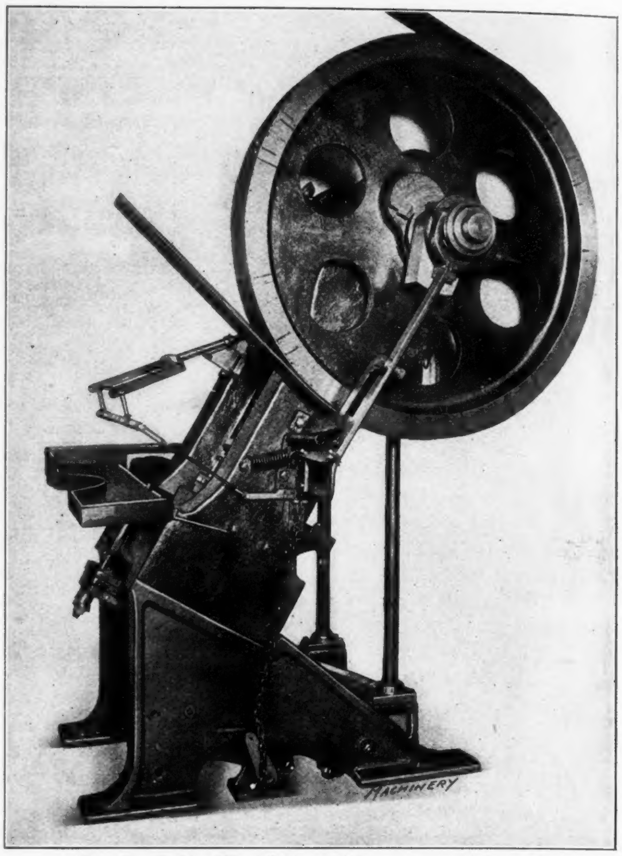


Fig. 5. Corbin "Lock" Type of Power-press Safeguard

Fig. 4. H. & A. Lock "Push Guard"

Lock Guards

In this class belong those guards which so lock the clutch that the treadle will not operate the machine until the fingers are removed from the danger zone. In Fig. 2 there is illustrated a safeguard which is in use in a large number of factories in the United States. It is a product of the Lockhart Hodge Co., 12 Waverly St., Buffalo, N. Y. As the foot of the operator depresses the treadle of a machine equipped with this guard, a long lever swinging on a pivot is drawn down and carries with it the gate that descends in front of the dies. This gate drops almost to its lowest point before it reaches the bottom of the yoke, and it is only when the bottom of this yoke has been reached that a downward movement is communicated to the rod leading to the latch which sets the press in motion. From this it will be seen that the gate must be flush with the bed plate before the latch will operate to set the machine in motion. Therefore, should a person's fingers be under the gate at the time he depresses the treadle, the machine will not operate until such time as he withdraws them. Means are provided in connection with this guard to prevent the gate from rising until the press is again at rest.

Another make of guard working on somewhat the same principle as that just mentioned is shown in Fig. 3. It consists of a lever fulcrumed to one side of the press frame and attached at the end to a folding gate. A rod joins this lever to the rod leading to the clutch treadle and, depressing the treadle, causes the gate to unfold before the clutch engages. Should the operator place his fingers or anything else which is more than 1/8 inch in thickness in front of the descending gate, the clutch will not be tripped until he has removed it. This guard is made by Geuder, Paeschke & Frey Co., Milwaukee, Wis.

One of the simplest, and at the same time a very effective guard of the lock type is illustrated in Fig. 5. It consists of a free swinging rod of wood or other light material which is suspended across the front of the machine. In the operating position it hangs straight, but should the employe put his hand in the danger zone the rod will be swung forward by contact with his arms, causing a second rod attached to it to

lock the trip. The wood rod is attached to a bracket on the machine and can be removed or replaced at will. The Corbin Cabinet Lock Co., New Britain, Conn., is the manufacturer.

Fender Guards

In this class belongs those guards which completely surround the danger zone. There are very few guards of this kind, since they can, by the nature of their construction, be used in only a limited number of cases. In Fig. 6 is illustrated a safeguard of this type which is in use in Germany. The construction closely resembles that of a collapsible cup fitted to the under side of the ram, bottom side up; and the moving ram oscillates, as it were, within the cup. The cup is so adjusted for height that the fingers of the operator cannot pass between the edge of the cup and the bottom die. The sheet metal, however, can be fed through the space that is left. It will be plain, therefore, that the work can be fed to the danger zone but the fingers are not allowed to get through. As the ram descends upon the stock the cup collapses, as the rings of which the cup is formed slide within each other. On the up stroke the cup extends itself again, leaving room for the strip of stock to pass beneath its lower edge. If any variation in the thickness of the strip occurs, the cup collapses accordingly. This guard, which was developed by the Allgemeine Elektricitäts Gesellschaft, Berlin, Germany, can be used in most cases on the large machines, and is only effective for primary operations.

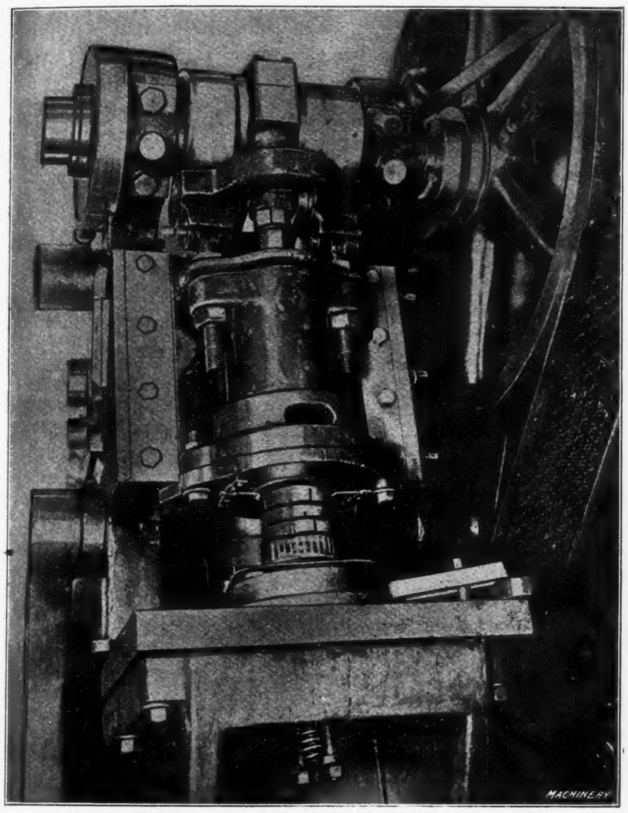


Fig. 6. Fender Type of Safeguard for Primary Operations

Hand Operated Machines

In the machines previously discussed, the clutch which actuates the ram is operated by the workman's depressing a treadle with his foot. He does not need his hands to operate the machine, only using them to place or feed the stock in the dies. In the class now to be considered, both the feeding—if there is no automatic feed—and the operating are done by either one or both hands. Nothing would be gained as regards safety by having only one hand do the engaging; therefore, practically no machines are in existence which depend on this operating method. Should a machine requiring a lever movement by both hands to make it operative be automatically fed, then the workman would not have to take his hands off the operating mechanism and he would be able to work faster, at the same time keeping his hands away from the danger zone. But should there be no automatic feed attached to the machine, the workman would not be able to work as fast as in the case of a machine having a treadle engagement and fitted with one of the guards previously mentioned. An advantage of this class is that there is no rhythmic movement which will be dangerous, and any noise or movement on the operator's part will not result in an accident. For this reason the two-handed engagement principle is by far the best safeguard.

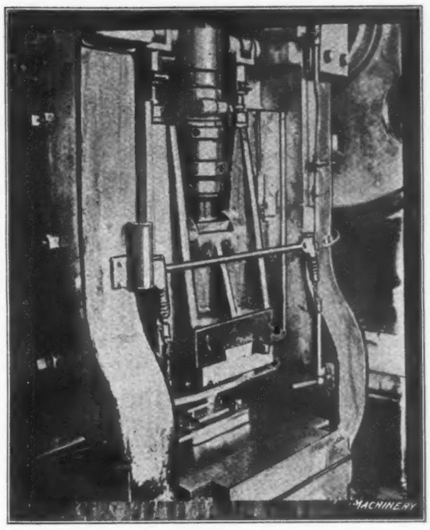


Fig. 7. Type of "Two-handed" Guard

Fig. 8 shows a machine equipped with a safeguard made by the Benjamin Electric Mfg. Co., Chicago, Ill. It has two levers placed one on each side of the machine, which are required to be pressed down by the hands of the operator before the clutch is engaged with the flywheel. The pressing of one lever will not start the machine. Another safeguard of this class is illustrated in Fig. 7 where the two handles in the illustration must be moved forward by the hands of the employe to operate the machine. This guard is used by the National Cash Register Co., Dayton, Ohio.

There are two kinds of guards which cannot be put in any class. The first is an amusing German suggestion to secure safety by placing a belt around the waist of the operator, and from a ring on this belt at each side having a short chain or strap passing around his elbows and then back to the ring. The length of the chain is so adjusted that the operator is able to place the pieces in the feeding mechanism in front of him but is not long enough to get his hands in the danger zone while sitting at his work. This safeguard can only be used where an automatic feed mechanism is attached to the machine, as it would not be a safety device without an automatic feed. This guard will probably never be used on this side of the water as no American workman would stand for having himself hampered in this manner.

Fig. 8. Benjamin Guard that requires the Use of Both Hands to trip the Press

The second guard referred to, which is a more practical suggestion, is that the bed plate or die shall be in connection with an electric battery, with a condensing coil on the line. The plate shall be put in circuit by the motion which throws in the clutch, so that any fingers resting on this plate will receive a sharp shock and the muscles involuntarily contract, thus pulling the endangered fingers out of the path of the descending ram. This requires that the electrified plate shall be insulated from the metallic strip which the operator is feeding, and that the operator shall be grounded while at work, so that he may receive the shock when his fingers are in the danger zone. This idea is probably taken from central station practice, where the tools on a tool board are electrified to prevent unauthorized persons being tempted to take them. The shock they will receive as the tool is detached will usually cause it to fall from the hand which grasps it, and a considerable surprise and probable alarm is administered to the offender. To use this idea as a safeguard on a power press is both novel and interesting.

A guard should be made so that it will protect the worker against the possibility of his putting his hands in the danger zone from either side of the machine, as well as from in front, if it is to meet all the requirements of a guard. The guard shown in Fig. 6 meets this requirement while those illustrated in Figs. 1, 2, 3, 4 and 5 do not show that this condition has been met. A guard must not hamper the workman by preventing him from turning out the maximum number of pieces per day, and it should be so attached to the machine that it cannot readily be removed and not used. It should also consist of as few parts as possible. The guard shown in Fig. 2 is composed of a number of parts and is almost impossible for the operator to remove without spending considerable time; while Fig. 5 shows a guard which has very few parts and can easily be removed.

It cannot be said that any one of the preceding guards would meet all conditions under which a press may be used. It is a fact that with this class of machines very few of the guards are used continuously in the manufacture of one form or finished piece. It is more than likely that one machine will be used on different classes of work during a period of one year, and it has been found that each class of work would need its own special type of guard. On this account it is very hard for the employer to determine what make of guard he shall purchase.

* * *

The International Engineering Congress which meets in San Francisco, Cal., September 20-25, inclusive, will treat of engineering problems broadly. A symposium of subjects of great interest to all engineers is that on materials of engineering construction. The list of topics that will be treated in this section are as follows:

1. Timber.
2. Preservative Treatment of Timber.
3. Substitutes for Timber in Engineering Construction.
4. Brick in Engineering Structures.
5. Clay Products in Engineering Structures.
6. Probable and Presumptive Life of Concrete Structures made from Modern Cements.
7. Aggregates for Concrete.
8. Slag Cement.
9. Waterproof Concrete.
10. Cements containing Additions of Finely Ground Foreign Material.
11. Economics of the World's Supply of Iron.
12. The Life of Iron and Steel Structures.
13. The Employment of Special Steel in Engineering Construction.
14. The Place of Copper in the Present Engineering Field, and the Economics of the World's Supply Thereof.
15. Alloys and Their Use in Engineering Construction.
16. Aluminum in Engineering Construction.
17. The Influence of the Testing of Materials upon Advances in the Designing of Engineering Structures and Machines.
18. Cement Testing.
19. Testing of Metals.
20. Testing Full-sized Members.
21. Proof Testing of Structures.

Further information may be obtained from W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

METHOD OF CALIPERING A FIVE-FLUTED TAP

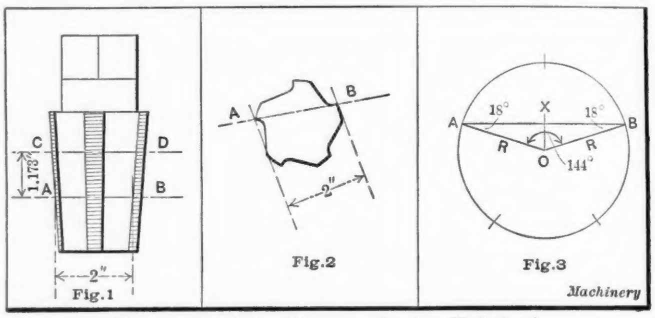
BY JOHN T. ENWRIGHT*

It is often necessary—especially in boiler work—to fit plugs by the size indicated by chalk on a five-fluted tap. For this purpose, the inside of the hole to be tapped is covered with chalk which marks the depth to which the tap has penetrated. When a tool with an even number of flutes is used, the required size for the plug can be taken directly from it. In the case of taps with an uneven number of flutes, however (generally five) a computation is required to secure the desired dimension. The method of making this computation is explained by the following.

The first step is to caliper the tap on the cutting edges at the point which marks the extent to which it has entered the hole. This would be at the line AB in Fig. 1. The dimension so obtained is multiplied by the constant 0.0489 and the product divided by the taper of the tap in inches per inch. The next step is to measure a distance AC parallel to the axis of the tap and then caliper the diameter at this point. The measurement of the tap on the line CD represents the size of the hole which is tapped out when the tool enters to the depth marked by the line AB. The distance AC measured parallel to the axis of the tap is determined by the following formula:

$$AC = \frac{\text{Diameter} \times 0.0489}{\text{Taper in inches per inch}}$$

To illustrate the method of using this formula, the following problem will be carried through. Consider a case in which the dimension of the tap calipered on the line AB is 2 inches and the taper of the tap 1/12 inch per inch. The required distance AC at which the tap must be calipered to obtain the true size of the hole is then found to be



Figs. 1, 2 and 3. Diagrams showing Method of deriving the Formula

$$AC = \frac{2 \times 0.0489}{\frac{1}{12}} = 1.173 \text{ inch}$$

The method of deriving the formula for the distance AC is as follows: Referring to Fig. 3, AB corresponds to AB in Figs. 1 and 2. The triangle AOB is an isosceles triangle in which the angle $AOB = 2/5 \times 360 = 144$ degrees. The angle $OAB =$ angle $ABO = \frac{1}{2}\ (180 - 144) = 18$ degrees. $OA = OB = R =$ radius of the tap. The next step is to bisect the angle AOB so that $AX = BX$. By construction, the angle OXA is a right angle.

$$\frac{XA}{R} = \cos 18 \text{ degrees}$$

$$XA = R \times \cos 18 \text{ degrees} = R \times 0.9511$$

$$AB = 2\,R \times 0.9511 = D \times 0.9511$$

The difference between the true diameter of the five-fluted tap and the size calipered on the line AB is found to be:

$$2\,R - 2\,R \times 0.9511 = 2\,R \times 0.0489 = D \times 0.0489$$

The product of the diameter D by 0.0489 is divided by the taper of the tap in inches per inch, in order to obtain the distance AC which must be measured parallel to the axis in order to determine the location of the line CD on which to caliper the tap to determine the size of the hole that it will produce when it enters the work to the line AB.

* Address: Sayre, Pa.

SAFETY AS APPLIED TO GRINDING WHEELS*†

CAUSES OF GRINDING WHEEL ACCIDENTS AND MEANS OF AVOIDING THEM

ALL rapidly moving machine members present possibilities for the occurrence of serious accidents, and in view of the fact that it is necessary to operate grinding wheels at such speeds that the cutting surface travels at about a mile a minute, more than usual precautions must be observed in their operation in order to provide for the safety of the operators. These precautions may be sub-divided under two headings; first, to eliminate as far as possible, all causes which are known to have been responsible for grinding wheel breakages; second, to provide adequate means of protection for men and property in event of a wheel breaking. Reputable manufacturers of grinding wheels test each wheel before it is shipped. This is done by rotating the wheel at a speed which subjects it to between three and four times the centrifugal force that would be exerted when operating under average conditions. The wheel is then marked by the inspector to show that he has found its condition satisfactory.

The design and condition of grinding machines as well as the foundations on which they rest, are very important factors in the prevention of accidents, as such accidents can often be traced to these causes. The modern grinding machine with its heavy spindle and massive base, and its long closely adjusted bearings, is responsible for the elimination of many accidents which would otherwise occur. Grinding machines should be kept in good condition and they should be mounted on a rigid foundation. Machines used for rough work, such as snagging castings, are frequently subjected to severe abuse and it is significant that statistics show that the majority of grinding accidents occur in foundries where such conditions exist.

Causes of Grinding Wheel Accidents

1. *The wheel receives a blow from the side.*
2. *The work-rest is improperly adjusted.*
3. *The wheel is unduly heated by forcing the work excessively.*
4. *The operator is careless in handling heavy work, thus causing the wheel to be damaged.*
5. *The wheel is mounted between flanges of unequal size.*
6. *The flanges have an uneven bearing against the wheel.*
7. *The wheel is running out of truth.*
8. *The inside flange is loose on the spindle.*
9. *The spindle is too tight a fit in the hole in the wheel.*
10. *The flanges are not provided with the necessary relief to assure an even bearing.*
11. *The nut on the spindle is tightened excessively.*
12. *The washers are either too small or omitted.*
13. *The spindle and spindle bearings become overheated.*
14. *The wheel is run at too high a speed.*
15. *The wheel is mounted in such a way that the nut on the spindle works loose.*

Methods of Avoiding Grinding Wheel Accidents

1. *The use of protection hoods or safety flanges to provide for the safety of the operator in the event of the wheel breaking.*
2. *The use of wheels which have been subjected to a speed test by the grinding wheel manufacturer to discover any defects which may exist.*
3. *Testing each wheel before it is mounted on the grinding machine ready for use.*
4. *The use of machines of the necessary rigidity and the mounting of such machines on rigid foundations.*
5. *The exercise of the necessary supervision on the part of the superintendent or foreman to be sure that none but wheels of the proper size are used on each machine, and that these wheels are driven at suitable speeds.*
6. *The use of goggles and spark shields to protect the eyes of the operators from injury.*

A somewhat unusual cause of breakage of grinding wheels is that resulting from undue heating of the wheel. In such cases this is usually due to the wheel becoming glazed so that excessive pressure is necessary to maintain the desired rate of production. Where this condition exists, the wheel is unduly heated at its periphery and this leads to uneven expansion, resulting in rupture. This danger is eliminated by keeping the wheel properly dressed at all times. Another source of danger arises from the possibility of damaging wheels used in snagging castings. Where the casting is suspended by a chain hoist as shown in Fig. 1, the operator may allow the casting to strike the side of the wheel with sufficient force to either break it directly or weaken it so that it will break later on.

The relative merits of safety flanges and safety hoods were discussed in a previous paper (see MACHINERY, January, 1914). While one of these measures is very necessary for use on all grinding wheels, the observation of suitable precautions in mounting the wheels is a most important factor in preventing them from breaking. Fig. 2 illustrates an example of dangerous mounting. The outside flange was lost and the operator substituted a small washer in its place. This produces such a severe strain on the wheel that it either breaks immediately upon attaining the operating speed or soon after it is put to use. Fig. 3 shows how an accident was caused in a factory in the Middle West. The operator had a piece to grind that was of such a shape that the outside flange on the wheel interfered with the work. Without obtaining permission from anyone, he removed the nut and the outside flange, and then obtained a rough forged washer in which—for some unknown reason—he was very careful to hammer a lead bushing from an old grinding wheel. He then mounted the wheel as shown. The man lost his life from the breakage which resulted when he attempted to work with the wheel in this condition.

In order to avoid accidents resulting from broken wheels, be sure that the flanges used are of equal size and that their diameter equals at least one-half of the diameter of the wheel. It is also highly important for the flanges to have an even bearing on the wheel. Where the bearing is uneven, it is usually caused by the flanges being damaged to such an extent that they lose their original shape. In rare instances, flanges have been used which were not machined, but were taken right from the casting in the sand. Such practice brings unequal stresses to bear on the wheel and a breakage is the logical result. The wheel must also run true, in order to avoid subjecting it to uneven strains. When it does not run true, it may be due to the hole in the wheel being much too large for the size of spindle, or to the fact that the flanges do not hold the wheel properly. This, in turn, may be caused by the nut becoming wedged on the spindle before it has been drawn up to the flanges, due either to dirt in the thread of the spindle or in the thread of the nut. The man mounting the wheel gets the impression that he has properly drawn up the flanges against the wheel, when such is not the case. Another cause for wheels running out of true is directly traceable to failure to give proper attention to the machine bearings. The bearings become highly heated, the bearing metal flows, a heavy brake action is produced on the spindle, and when the machine is stopped the momentum of the grinding wheel is sufficient to loosen the mounting. When the wheel is started again the nut will not automatically tighten and the wheel will be running under a dangerous condition.

Wheels should not be allowed to remain partly submerged in water, because they will be badly out of balance when started. Some people seem to believe that water has a detrimental effect on grinding wheels. This is not true of modern grinding wheels; even those bonded by means of silicate bonds are made waterproof. Another noteworthy precaution is to have the inside flange either keyed or pressed on the

* For other articles on the safeguarding of grinding machines published in MACHINERY, see also "Grinding Wheel Protection Devices," by R. G. Williams, January, 1914; "Guards for Polishing Wheels," November, 1913; "Prevention of Industrial Accidents," by F. R. Hutton, April, 1912; "The Bursting of Emery Wheels," July, 1903; and "Fastenings for Emery Wheels and Grindstones," December, 1902.

† Paper by R. G. Williams presented before the National Machine Tool Builders' Association convention, Worcester, Mass., April 24, 1914.

spindle. Accidents have been known to result from the work being rubbed against a loose inside flange, thus exerting a brake action on the flange, which in turn, caused the nut on the spindle to crawl. In this way, enough pressure was exerted on the wheel by the flanges to crush it.

An accident may result by having the wheel screwed on the spindle when the hole is too tight a fit. The illustration Fig. 4 shows the result when the hole is too small for the spindle. The lead bushing becomes deformed by the wheel being screwed on over the spindle, with the result that each flange only bears on the wheel for a small distance. The remedy for this is to make sure that the hole is of such size that the wheel will slide on the spindle easily. Fig. 5 shows a possible result from the use of unrelieved flanges. As an illustration, consider an instance where the operator exerts excessive pressure on the nut when mounting the wheel. This causes straight flanges to become slightly convex, as shown in the illustration, and concentrates the retaining pressure near the center of the wheel instead of distributing it uniformly throughout the area of the flanges. The remedy for such a situation is to have the flanges—either straight or beveled—relieved to such an extent that a bearing surface approximately 1/16 of the diameter of the flanges is left near the rim. By the excessive tightening of the nut, sufficient pressure can be set up between the wheel and the flanges to crush the structure of the wheel. It has been calculated that where the size of the spindle is 1½ inch in diameter, a man with a four-foot wrench can exert a pressure between the wheel and the flanges of over a ton and a half. The nut should not be tightened more than enough to hold the wheel firmly.

Washers of blotting paper or some other compressible material should be used between the wheel and the flanges. These tend to distribute the stresses set up when the flanges are tightened against the sides of the wheel. The washers should be somewhat larger than the flanges. It is possible for a small piece of metal to become caught in some way between the wheel and the flanges, which, if no compressible washer is used, will cause an excessive strain to be set up at this particular point when the flanges are tightened. The use of compressible washers in such an instance tends to distribute such unequal stresses. When the spindle becomes overheated, the heat is conducted to the lead bushing of the wheel, which may expand to a point where it causes the wheel to break. This danger can be readily overcome by proper attention to the bearings of the machine. Another possibility of accidents is due to the fact that a careless workman may so equip the machine that the revolutions per minute of the spindle is far too great for the particular size of wheel in use; or it may possibly be that through a foreman's desire to increase production, he speeds up the wheels so that they will cut faster. Again, where a machine is equipped with cone pulleys and the belt is loose, it is possible for the belt to automatically shift to a smaller step and thus greatly increase the speed of the grinding wheel. Sometimes ignorant workmen will mount large wheels on a machine which is equipped and intended for very much smaller ones, thus creating a dangerous condition.

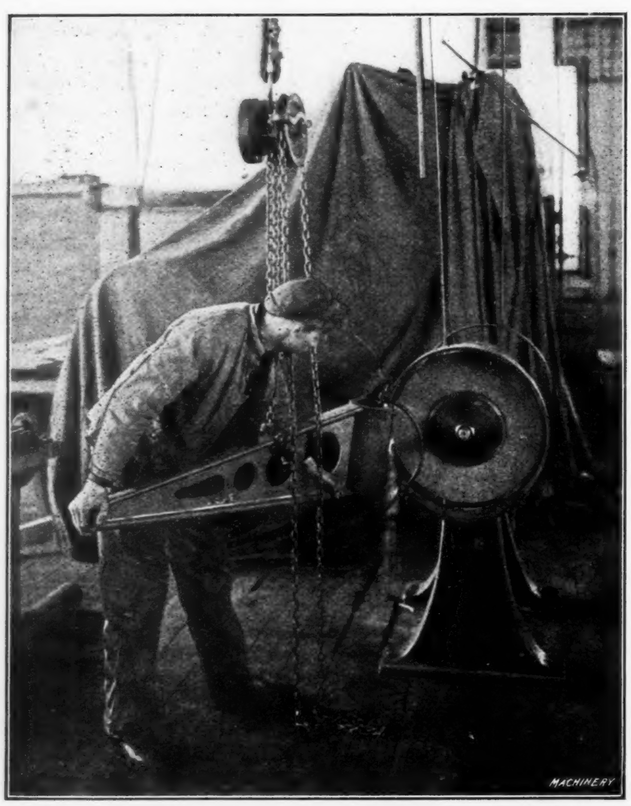


Fig. 1. Snagging a Heavy Casting supported by a Chain Hoist

TABLE OF SMALLEST SPINDLES FOR VARIOUS SIZES OF GRINDING WHEELS

Diameter of Wheel	Maximum Thickness of Grinding Wheels in Inches													
	1	1¼	1½	1¾	2	2¼	2½	3	3½	4	4½	5	5½	6
8	¾	¾	¾	¾	¾	¾	1	1	1	1	1¼	1¼	1¼	1¼
9	¾	¾	¾	¾	1	1	1	1	1	1¼	1¼	1¼	1¼	1¼
10	¾	¾	¾	1	1	1	1	1	1¼	1¼	1¼	1½	1½	1½
12	¾	1	1	1	1	1¼	1¼	1¼	1½	1½	1½	1½	1¾	1¾
14	1	1	1	1¼	1¼	1¼	1¼	1½	1½	1¾	1¾	1¾	1¾	1¾
16	1	1¼	1¼	1¼	1½	1½	1½	1¾	1¾	1¾	1¾	1¾	1¾	2
18	1¼	1¼	1¼	1½	1½	1½	1¾	1¾	1¾	1¾	2	2	2	2
20	1¼	1¼	1½	1½	1¾	1¾	1¾	1¾	1¾	2	2	2	2	2¼
22	1¼	1½	1½	1¾	1¾	1¾	1¾	2	2	2	2	2¼	2¼	2¼
24	1½	1½	1¾	1¾	1¾	1¾	2	2	2	2	2¼	2¼	2¼	2½
26	..	1¾	1¾	1¾	1¾	2	2	2	2¼	2¼	2¼	2¼	2½	3
28	..	..	1¾	1¾	2	2	2	2	2¼	2¼	2¼	2½	3	3
30	..	..	1¾	2	2	2	2	2¼	2¼	2¼	2½	3	3	..
32	..	..	2	2	2	2	2¼	2¼	2½	2½	3	3	..	..
34	..	..	2	2	2	2¼	2¼	2½	2½	3	3	..	..	..
36	..	..	2	2	2¼	2¼	2¼	2½	3	3	..	..	..	..

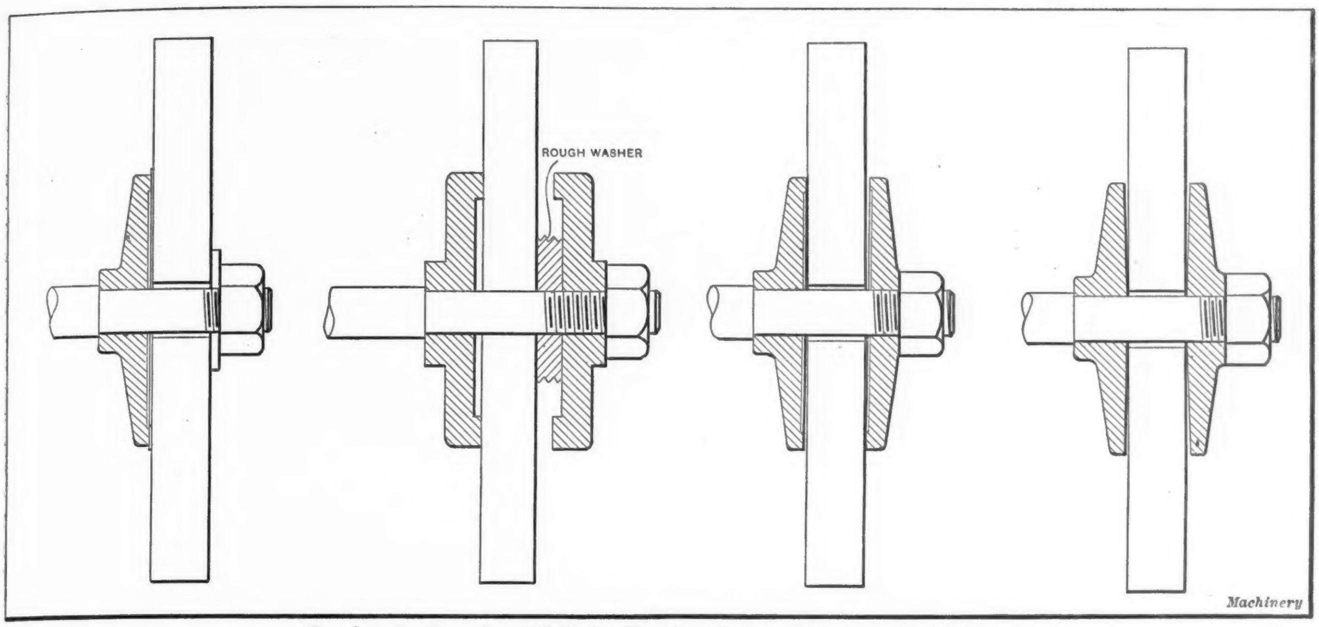
Machinery

Polishing stands are sometimes used for rough snagging work, with wheels which are much too heavy for this type of machine. Bench and floor types of grinding machines are usually designated by the size of the spindle on which the wheel is mounted. It is, therefore, a common practice to designate the maximum size wheel to be used on any machine by tabulating spindle sizes and wheel sizes, as presented in the above table. An accident may be caused by mounting a wheel so that the nut works loose, which will cause the wheel to run badly out of true. This can happen in three ways: 1. A machine is taken apart for repair and when set up the spindle is turned end for end from its original position. 2. The motor or shafting which drives the machine is changed so that it will revolve in the opposite direction from which it should. 3. When putting on a new belt, an unreliable workman may use a twisted instead of a straight belt. All of these conditions can be very easily remedied by a little care on the part of some responsible person. In addition, belt locking devices may be used, and so set in the base of the machine as to make it impossible to mount too large a wheel. To further guard against such mistakes it is good practice to have a special notice attached to each machine giving information as to the size of the wheel to be used, the number of revolutions per minute at which the wheel should be run and the class of work for which it should be used.

Exhaust Systems and the Use of Goggles

Laws in almost every country require the removal of dust from grinding. This necessitates the use of a hood, and if a hood must be used, it might just as well be strong enough to offer protection in case of the wheel breaking. A proper hood affords complete protection, which flanges cannot give; but in instances where a hood would interfere with the proper use of the wheel, flanges offer the next best method of protection. There are many satisfactory types of protection hoods on the market, the reason for more than one type being found in the variety of grinding operations.

There are several satisfactory designs of goggles for grinding, and every operator doing snagging work should be required to wear them. Since the particles cut off by grinding wheels are comparatively small, a heavy type of goggle is not necessary. Goggles should have side guards of wire or



Figs. 2 to 5. Examples of Defective Mountings that are likely to cause Accidents

leather, as particles coming from the side have been known to enter the eye. A glass spark shield which can be attached to the top of a protection hood is found very satisfactory where wheels are used intermittently, as in the case of a general purpose wheel in a machine shop. It is recommended that wire glass be used. Glass spark shields have not been found entirely satisfactory where wheels are used continuously, however, due to the fact that the glass soon becomes pitted from the heated chips of metal. Another form of protection from grinding wheel sparks is a device consisting of a piece of leather attached to the top end of a protection hood and extending down over the face of the wheel, a slot being cut in the leather of the approximate width of the grinding wheel.

Dressers

Grinding wheel dressers are sometimes the cause of accidents. If the work-rest is not properly adjusted there is a possibility of the dresser being caught between it and the wheel, and the revolving cutters sometimes break into pieces large enough to cause serious damage. A type of dresser is recommended which has a hood as an integral part of the handle, the hood serving to protect the user in case the cutters break. The ordinary type of dresser can be made more safe by attaching a thick guard of sheet iron over the cutters.

There is great need for the standardization of grinding wheel protection devices. This subject is to be taken up in the near future by the National Council for Industrial Safety and the National Machine Tool Builders' Association. These two organizations will consider all the important phases of this subject and endeavor to arrive at specifications which can be adopted as standard for protection devices used in connection with grinding wheels. In conclusion, it is gratifying to note that the efforts for safety as applied to grinding wheel operations are accomplishing results, in that the number of serious accidents is rapidly decreasing. We will always have a few unpreventable accidents, but until every preventable accident has become a thing of the past, we should strive for a better understanding and an improved use of the modern safety devices for grinding wheels.

* * *

PREVENTING MOISTURE FORMING ON WATCHMAKERS' EYE-GLASS

In certain branches of the machinist's trade, and especially in fine toolmaking, the use of a watchmaker's eye-glass is frequently required for long periods. It will be found that after the eye-glass has been in continuous use for a certain length of time—depending principally upon the temperature of the surrounding atmosphere—the lens becomes covered with mist on the side nearest the eye. This interferes with the use of the glass.

There are many good preparations on the market which can be rubbed on the lens to prevent this "fogging," but as they are more or less opaque, they are not to be recommended when accurate work is essential. A very simple and effective method which is found in use in some shops is to drill four equally spaced holes through the hard rubber shell about 1/8 inch back of the lens. A No. 54 drill is about right for this purpose. If this method is followed the eye-glass can be kept in the eye indefinitely without "fogging" the lens.

G. G.

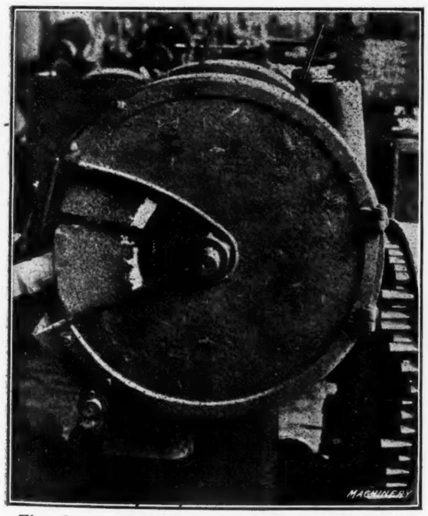


Fig. 6. An Efficient Type of Protection Hood used by the International Harvester Co.

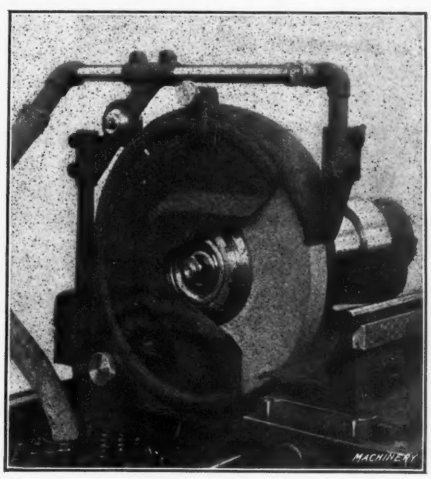


Fig. 7. Type of Protection Hood applied to Norton Grinding Machines with Satisfactory Results

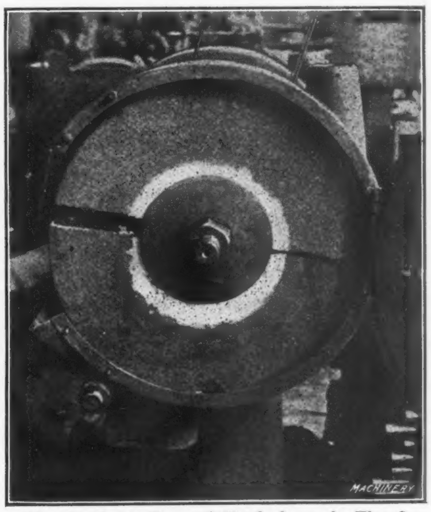


Fig. 8. Same Type of Hood shown in Fig. 6, with End Cover swung back

THE VALUE OF A PATENT*

BY FORD W. HARRIS†

There are no questions in relation to patents more important than those which deal with their commercial value. Practically all patents are applied for with the idea of making profits, and the value of a patent is the one great question in which every inventor is interested. This article is intended to indicate how an approximate value of a patent may be arrived at. It may be said in the beginning that there is a popular misconception of the true meaning of the grant of letters patent. In the popular mind a patent is a licence for the inventor to build the thing disclosed in the drawing and the specification, and, further, a legal bar to prevent others from building, making or using that thing. These, to the popular mind, are the purposes of a patent—first, to allow the inventor to use, and second, to prevent everyone else from making or using the invention.

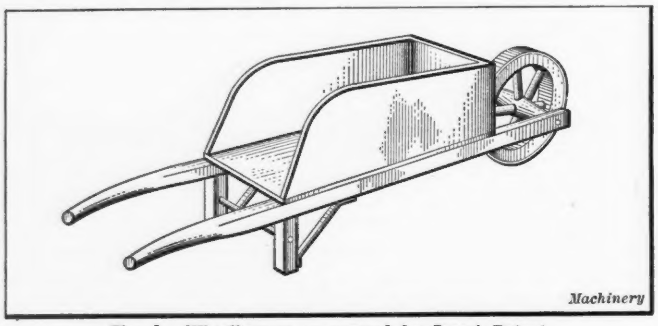


Fig. 1. Wheelbarrow as covered by Jones' Patent

The first of these, that is, the license purpose, is not the intention of the patent. The law does not contemplate licensing an inventor. It merely contemplates giving him a monopoly; that is, he can stop others from making, renting or using the invention claimed in his patent, but whether he can do so himself or not depends on several things. This and the points to follow can best be illustrated by specific cases. For example, let us assume that no one has ever invented a common wheelbarrow and that Jonas Jones has a patent on it, as illustrated by Fig. 1. Let us further suppose that he has claims as follows:

1. A barrow comprising a load-holding means, wheel means at the forward end thereof, and handle means at the rear end thereof.

2. A barrow comprising a load-holding body, a wheel supporting the forward end of said body, legs supporting the rear end of said body, and handles by which the rear end of said body may be raised.

3. A barrow comprising two handle members having handles formed on one end thereof, a wheel supported between the other ends of said handle members, a rectangular body supported on said handle members, and legs extending donwardly from the said handle members.

Let us further suppose that Jones was clearly entitled to these claims and that his invention is the very first that even remotely resembles a wheelbarrow. In this case the government has given him a broad patent and one that is difficult to avoid infringing. Claim (1) is very broad, covering as it does the combination of any sort of a load-holding means, any sort of wheel means at the forward end of the load-holding means, and handle means at the other end of the load-holding means. While it could be avoided by placing the wheel and the handles on the same end or by omitting one of the three elements named, it is evident that if this is done we will not have a wheelbarrow. It will be noted that this claim does not specify any legs. Nevertheless it cannot be avoided by adding legs. In other words, if the three elements specified in the claim are used for the same purpose and in the relation specified in the claim, the claim cannot be avoided by adding another element.

Let us now suppose that Bronson Brown invents the wheelbarrow shown in Fig. 2 after Jones has obtained his patent. The patent office would grant claims about as follows:

1 A. A barrow comprising a saucer-shaped metal load-holding means, wheel means at the forward end thereof, and handle means at the rear end thereof.

2 A. A barrow comprising a load-holding means, wheel means at the forward end thereof, hinged handles at the rear end thereof, and locking braces for said handles.

To the average person it would seem that Bronson, having a patent which describes and claims a certain type of wheelbarrow, should be entitled to make, use and sell that wheelbarrow. As a matter of fact the issue of the patent has not affected Bronson's rights to make, use and sell in the slightest degree. His invention contains all the elements of the first claim of Jones and clearly infringes it. In other words, he has absolutely no right to make it until the Jones patent runs out.

His patent simply grants him a right to prevent others from making the structure claimed. An examination of Claim (1A) discloses that it is like Claim (1) except that it specifies a "saucer-shaped metal load-holding means." The claim grants to Brown the sole right to use such a load-holding means. Now Jones can prevent Brown from making any kind of a wheelbarrow, but Brown can prevent Jones from using his peculiar type of load holder. The patent to Jones is broad or generic, while the patent to Brown is narrow or specific. If no patent had ever been granted to Jones and the wheelbarrow shown in Fig. 2 was the first of its class Claim (1) could have been granted thereon as well as upon the wheelbarrow shown in Fig. 1. If, however, Brown's attorney were incompetent, and asked only for Claims (1A) and (2A), these would be all the claims Brown would get. In this case any one could build the wheelbarrow shown in Fig. 1, as this neither has the "saucer-shaped load-holding means of Claim (1A), nor the "hinged handles" of Claim (2A). In this case Brown would have lost a valuable invention due to having a poor attorney.

In the same manner Claim (3) of Jones patent specifies "a rectangular body supported on said handle members." If Jones had no broader claim than this, he could not stop Brown from making a body not rectangular, nor could he stop any one from doing this or from making a body supported otherwise than on the handle members. In other words, if Jones had only Claim (3) he would have a narrow, specific patent in the place of a broad generic one.

A patent covers what it claims, not what it shows. Every claim is a patent in itself and may be sued on and adjudicated

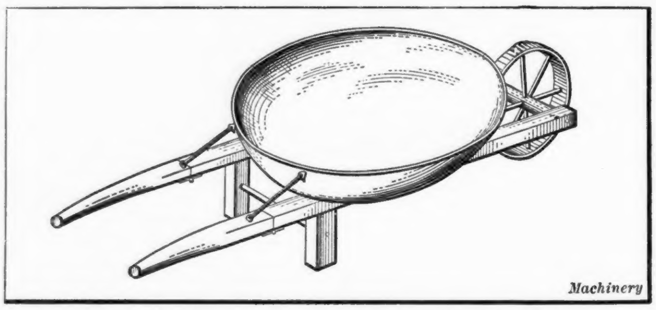


Fig. 2. Wheelbarrow covered by Brown's Subsequent Patent

quite apart from the remaining claims. Each claim consists of a combination of several elements modified by limiting clauses. Omitting one of the elements from a structure avoids that claim so long as an equivalent element is not added in its place. This is the general theory of claims.

Claims are, however, interpreted by the courts in the light of what has gone before. If, for example, Jones had antedated Brown by several years, and was clearly the first inventor of any sort of a wheelbarrow, the courts would not attach much importance to the "rectangular" in Claim (3). It might be argued that this distinction was immaterial and that the word had slipped in inadvertently. If, however, wheelbarrows like Fig. 2 were already known, it would be evident that Jones must limit himself to rectangular bodies to have a valid claim, and that the word "rectangular" would be essential and not inadvertent. The courts will also consider various collateral circumstances, such as the relation of Jones and Brown and the utility and value of the invention

* See MACHINERY, April, 1914, "Patents—Some Essential Facts for the Engineer," and other articles there referred to.
† Address: 1033 Higgins Bldg., Los Angeles, Cal.

at issue. For this reason the wording of claims is not always conclusive, but in general the rule is as stated.

Having now a certain patent, we wish to know its value. Let us suppose that Brown's patent is to be examined to determine its value, and let us further suppose that we know nothing of Jones' wheelbarrow. How shall we arrive at the value of the patent to Brown?

The first thing is to determine the prior state of the art at the time Brown applied for a patent. This can be done by having the patent office make a typewritten copy of the file-wrapper and contents, and send them to us with the references to prior patents found and cited by the examiner in the prosecution of the case. We can then carefully review the case, see what claims Brown made originally and what claims he had to cancel and abandon. We can see further just what the prior patents were with which he had trouble. If the case is very important we may send for file-wrappers and contents on some or all of these prior patents and study them. Further, we would go ourselves to the patent office and search the records for patents that the examiner did not regard as pertinent or overlooked in his search. This would all take time, but would result in a clear conception as to exactly what Brown was entitled to when he applied.

The claims in the Brown patent are then studied to see what the elements of the combination are, and to see if one or more cannot be omitted and yet have a commercial device. If one of these elements is not absolutely essential or if a limiting clause is present which may be omitted without hurting the article it is sought to manufacture, it may be at once said that the patent is of little or no value. Many patents are valueless on their face due to limiting clauses therein or to elements that are not essential. Many others are valueless because they are dominated by earlier and broader patents. The search in the patent office and the study of the data collected should disclose these broader patents if any exist. It may be said, however, that there is no sure way to find absolutely all the prior patents that may affect the right to manufacture an article. This is due partly to the fact that a claim for a collection of elements used, for example, in a wheelbarrow, may be found in a wagon, a railroad car or an aeroplane patent. You may be sure that you cannot manufacture an article due to a prior patent, but you can never be sure you are not infringing the rights of some one else.

Strictly speaking, the only way to determine a patent's value is to submit it to a lawsuit. After a patent has been passed upon by a Federal court and has stood the test of litigation its value may be said to be fixed. This is very expensive and slow, and no business man wants to wait for such action by the courts. There is no reason, however, why a competent patent lawyer cannot arrive very closely at a patent's value at a very moderate expense. Certainly, no one should pay for patent rights or embark in a business based wholly or in part on patent rights without first getting such an opinion.

* * *

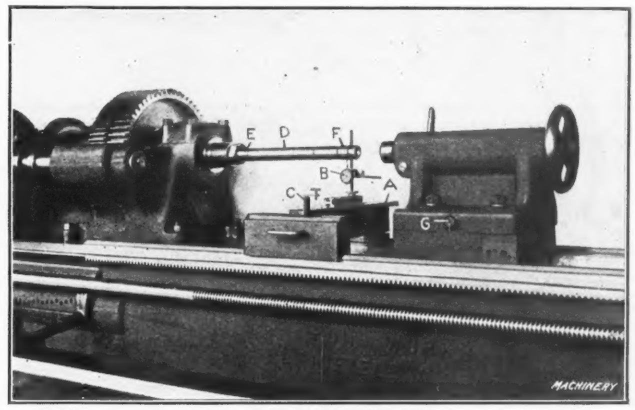
LINING UP ENGINE LATHE HEADSTOCKS AND TAILSTOCKS*

BY ALFRED SPANGENBERG†

The first requirement in aligning engine lathe headstocks and tailstocks on the beds is to determine the horizontal alignment, both as regards parallelism with the ways on the bed and relative height between the headstock and tailstock spindles. This is owing to the fact that if any errors are discovered which exceed the allowable limits of variation, the part at fault must be removed and either filed and scraped to bring it true, or machined if the circumstances warrant such a procedure. By the usual method of making this test, where the indicator is carried in a fixture fitting the bed vees or clamped in the regular carriage toolpost, it becomes necessary to first align the headstock and tailstock spindles sideways; otherwise, the line of motion of the indicator point in traveling from one collar to the other on the test-bar would not be parallel with the axis of the test-bar and the readings would be false.

A fixture that permits the testing of horizontal alignments regardless of the errors sideways, thereby saving much time, is shown in the accompanying illustration, which also shows a headstock and tailstock in position on the lathe bed ready for the test. As will be seen, the fixture fits the V-tracks on the bed and is provided with a plane surface *A* which is scraped true to support the Brown and Sharpe indicator *B*. The idea is to pass the indicator point under the test-bar in a crosswise direction, the maximum reading indicating the true height. Clamp *C* is used to clamp the indicator on the fixture when testing alignments sideways.

The method of "lining up" is to place the test-bar *D* in the taper hole in the headstock spindle, and with the indicator set as shown, the spindle is revolved slowly by hand to test the concentricity of the taper hole. A chalk mark is then



Fixture for aligning the Headstock and Tailstock, which permits of making Height Tests regardless of Sidewise Alignment

made on the test-bar and a corresponding mark on the spindle nose to denote a point that is a mean between the "high" and "low" points on the bar. All subsequent readings of the test indicator are taken from this point. This test is obviously necessary, since the bar is particularly likely to run out at its free end due to a number of conflicting elements, the error in any one of which may be infinitesimal. The fixture is now moved along to collar *E*. The indicator is passed under the bar in a crosswise direction and the indicator dial is set to zero at the highest reading. A similar reading is taken at collar *F* which shows the error as regards parallelism with the vees of the bed. The bar is then moved over into the tailstock spindle hole and readings are taken on both collars in order to test its parallelism and the relative height of both spindles. Each reading is properly noted on a suitable form, and if the errors are within the permissible limits of variation, the headstock is set parallel with the vees sideways and the dowel pin holes are reamed.

The setting of the headstock sideways is accomplished by again placing the test-bar in the head spindle and indicating on the side of the bar, the clamp *C* being utilized to hold the indicator rigidly. As was previously explained, the spindle was moved a quarter turn before this test so as to indicate on the same point on the bar. The indicator point is, of course, set at a height the same as that of the spindle axis, as nearly as the eye can judge, and at the same time the dial is set to read zero. After the head is set parallel and pinned, the test-bar is moved over into the tailstock spindle hole, and having adjusted the set-over screw *G* to bring this spindle in line with that in the headstock (the reading being zero, the same as before) the tailstock spindle is tested for alignment sideways.

In setting the indicator at the starting point, care should be taken to make the maximum movement of the indicator needle not exceed 0.005 inch above its normal position, as otherwise the spring of the dial supporting arms is likely to cause false readings, especially if there is considerable variation in the different readings.

* * *

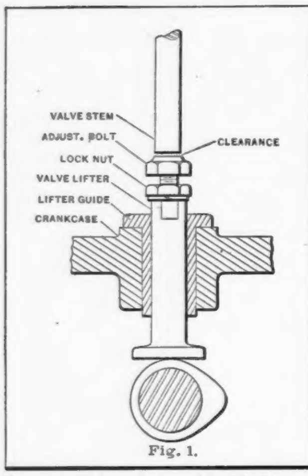
The city of Sheffield, England, has 400 concerns engaged in the manufacture of steel.

* For additional information on this subject, see also "Assembling a 24-inch Engine Lathe," published in MACHINERY for November, 1909; and "Repairing Lathes and Milling Machines," published in July, 1911.
† Address: 951 W. 5th St., Plainfield, N. J.

DYNAMICS OF GAS ENGINE CAMS*

A CONSIDERATION OF THE MUSHROOM TYPE OF VALVE LIFTER

BY M. TERRY†



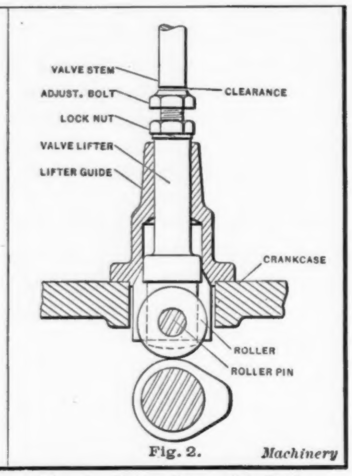


Fig. 1. Valve Gear with Mushroom Type of Lifter

Fig. 2. Valve Gear with Roller Type of Lifter

WHILE this article bears the same general title as those that appeared in MACHINERY for November and December, 1912, it is entirely independent of them, as it deals with a different type of cam. For the benefit of the readers who have missed the former series, the article here presented will be made as clear as possible without going into minute details and repeating what has already been published.

What is generally known as the mushroom type of valve lifter, used for actuating the valves of a gasoline engine, is shown in Fig. 1; and the more popular form of lifter—known as the roller type—is shown in Fig. 2. The main difference between the two types lies in the fact that the valve gear equipped with the mushroom lifter possesses fewer parts and requires less machining, piece for piece, than does a similar valve gear equipped with the roller type of lifter; in short, the former is cheaper to build. Its chief disadvantage lies in its noisy operation, and this characteristic —said to be inherent—has prevented its general introduction on pleasure cars, particularly those of the type that make their appeal to the buying public through their mechanical perfection rather than their low selling price. This statement is not made with the object of condemning the mushroom type of lifter; on the contrary, when we become acquainted with some of its peculiarities, a proper place will be found for it, where from a mechanical point of view it will be on a par with the roller type, and considered from a commercial standpoint will even be in the lead.

We shall now proceed to design a cam-shaft to meet the following requirements: Base circle of cam, 1.000 inch in diameter; cam lift, $3/16 = 0.1875$ inch; clearance between valve and valve lifter, 0.006 inch; timing, as per diagram shown in Fig. 3. All these conditions govern the shape of the two cams, and we shall presently commence with the inlet cam. Referring to the timing diagram, Fig. 3, we observe that the inlet valve is open for 200 degrees of the crankshaft circle. Since the inlet cam which directly actuates this valve is mounted on the half-time shaft, its active angle is 100 degrees. To this we must add twice the clearance angle to compensate for lost motion (due to clearance between the valve stem and the valve lifter) on the up and down strokes. In the mushroom type of valve gear, the clearance angle is determined entirely by the base circle of the cam and the radius of the arc AB, as shown in Fig. 4. The latter, in its turn, is governed by the lift of the cam, its active angle and also by its clearance angle. The relation being mutual and rather complicated, the writer has developed a very simple cut-and-try method which need never involve more than one trial.

* For additional information on this subject see "The Valve Problem on Gasoline Engines," published in the March, 1914, number of MACHINERY, and other articles there referred to.

† Address: 1063 Manning St., Flint, Mich.

In Fig. 4, the cam and its lifter are shown in a position where the latter is ready to rise. When in this position, the arc AB is tangent to the line MN and also to the base circle of the cam at the point A. The center from which the arc AB can be struck to satisfy these conditions must obviously lie on the vertical line AH. The active angle of the cam being 100 degrees, its center line cannot be less than 50 degrees from the line OA; as a matter of fact, the true angle made by the center line of the cam with this line OA is 50 degrees plus the clearance angle. Assuming that the clearance angle is 2 degrees, we draw our preliminary center line OF 52 degrees from OA. Next strike the arc CD with a radius of 0.6875 inch $(0.500 + 0.1875)$ which limits the lift of the cam; arc CD intersects OF at E. Now the arc AB should intersect our assumed center line OF at a point F such that OF is greater than OE. The reason for this is that if OF were less than OE, we would fail to obtain the required lift; and if OF were equal to OE, we would succeed in maintaining the required lift but the cam would terminate in a sharp ridge, which would be a poor design. Also, for the sake of quiet action (as will be proved later on) the radius of the arc AB must be as small as possible. Limited by these two conditions, there is left only a very small range through which the value of this radius can vary, and we select the nearest even dimension, namely 2½ inches.

As the cam revolves in a counterclockwise direction, the lifter rises and the point of contact between MN and AB moves to the right of A; at the same time, the center H of the arc AB describes an arc HH_1, with O as its center. But as long as MN remains tangent to AB, the distance between MN and H remains constant, namely 2½ inches, and hence the rise of the valve lifter at any instant must be equal to the rise of H above the horizontal line HI. If the lifter rises the distance MM_1, or 0.006 inch (clearance), H moves to a new position H_1, such that GH equals 0.006 inch; and the cam,

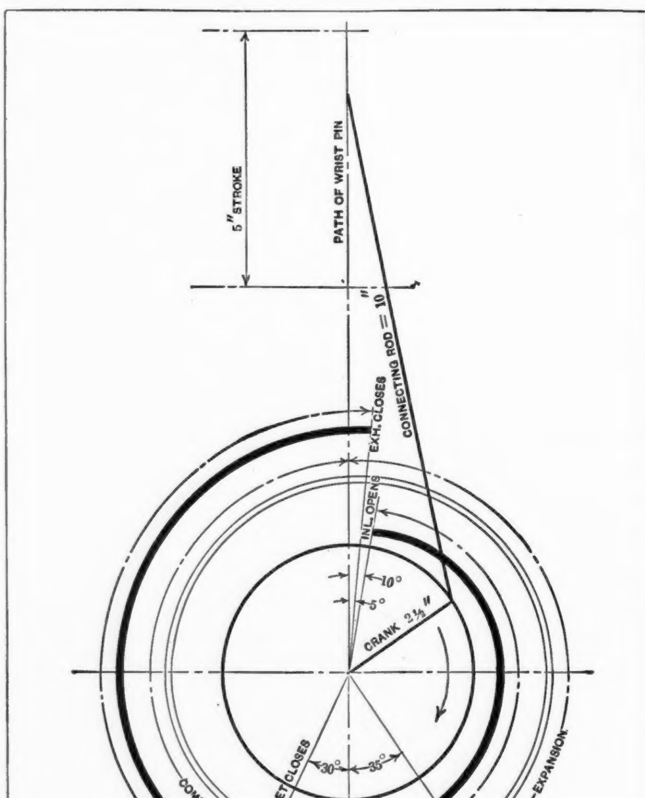


Fig. 3. Timing Diagram for the Cams

in the meanwhile, has turned through an angle α, which obviously is our clearance angle.

$$\cos \alpha = \frac{1.994}{2.000} = 0.997.$$

$$\alpha = 4 \text{ degrees } 30 \text{ minutes}.$$

The real center line of the ram is OE_1, which makes an angle of 54 degrees 30 minutes with OA and the total included angle of the inlet cam is 109 degrees as shown in Fig. 6. The common practice in regard to the fillet is to place its center on the center line of the cam, and our next problem consists in accurately determining the radius of the fillet which will be tangent to both AB and CD and whose center lies on OE_1. From Fig. 5 we find:

$OH = 2.000$ inches $= X$.

$OO_1 = 0.6875 - S$ inch $= Y$.

$O_1H = 2.500 - S$ inch $= Z$.

angle $HOO_1 = 125$ degrees 30 minutes $= \theta$.

$$\cos \theta = \frac{X^2 + Y^2 - Z^2}{2XY}.$$

cos 125 degrees 30 minutes = cos $(90° + 35° \; 30') = -$ sin 35 degrees 30 minutes $= -0.5807$.

$$\text{Hence } \frac{Z^2 - X^2 - Y^2}{2\,XY} = 0.5807.$$

Substituting actual values for X, Y and Z, we obtain

$$(2.500 - S)^2 - (0.6875 - S)^2 - 4 = 0.5807 \times 2 \times 2(0.6875 - S)$$

$$6.25 - 5S + S^2 - (0.4726 - 1.375S + S^2) - 4 = 1.5968 - 2.3228S.$$

By adding, subtracting and transposing we get:

$$1.3022S = 0.1806.$$

$$S = \frac{0.1806}{1.3022} = 0.139 \text{ inch}.$$

The object of determining the radius of the fillet in thousandths of an inch is to enable the toolmaker to form an accurate templet with the help of which he shapes the first master cam. The templet is shown in Fig. 8; in laying this out, the distance OO_1 must be given in thousandths of an inch, and this, of course, is impossible unless the radius of the fillet is accurately determined. The fillet hole is drilled first—in this case—with an under sized 9/32-inch drill; next, the base circle hole is drilled, and finally the remaining metal is removed by filing.

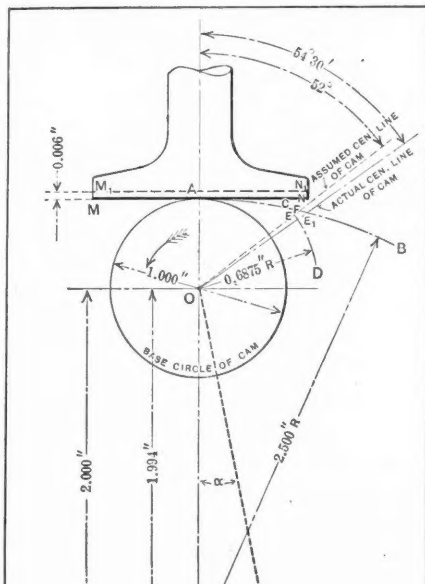


Fig. 4. Method of determining the Clearance Angle

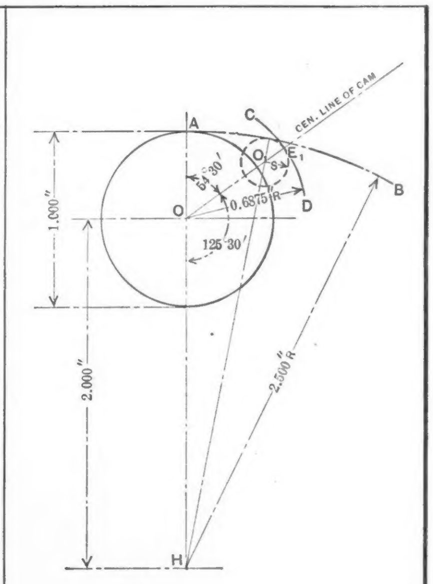


Fig. 5. Method of determining the Radius of the Fillet

The exhaust cam is generally made up of the same arcs as the inlet cam, except that, being wider, it possesses a dwell—amounting in this case to 10 degrees—as shown in Fig. 7. Considerable gain, so far as quietness of operation is concerned, may be secured by taking advantage of the wider angle of the exhaust cam for the purpose of shortening the radius of the arc that controls the clearance angle. It is evident from Fig. 4 that the shorter the radius of the arc AB, the greater is the clearance angle α for a given amount of backlash between the valve stem and the valve lifter; and it will be proved later on that, other things being equal, the greater the clearance angle for a given amount of backlash, the quieter is the valve gear. This principle has been pointed out in the analysis of the roller type of valve gear ("Dynamics of Gas Engine Cams," engineering edition of MACHINERY, November and December, 1912) and it applies equally well to the mushroom type.

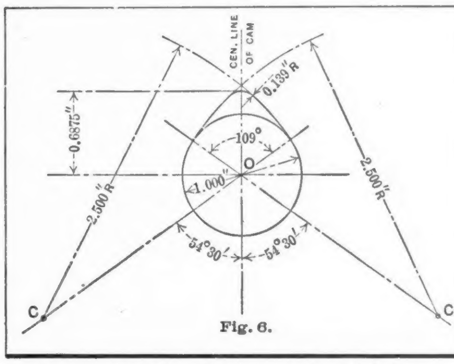


Fig. 6. Method of laying out the Inlet Cam

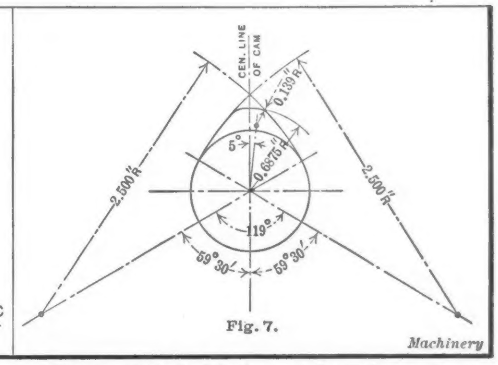


Fig. 7. Method of laying out the Exhaust Cam

Spacing of Cams

Our next problem is to space the inlet and exhaust cams that operate the same cylinder so as to secure the succession of events prescribed by the timing diagram shown in Fig. 3. The Otto cycle consists of four strokes of the engine, generally considered as taking place in the following order: First, suction or inlet stroke; second, compression stroke; third, expansion stroke; and fourth, exhaust stroke. Any suction stroke follows immediately after the exhaust stroke of the preceding cycle; or, to put it in other words, the action of the exhaust cam immediately precedes that of the inlet cam, which is also evident from Fig. 3. A simple graphical method for spacing the exhaust and inlet cams is shown in Fig. 9. With the cam-shaft revolving counterclockwise, we select the horizontal line OA for the center line of our exhaust cam. Fig. 3 calls for 220 degrees of exhaust valve opening; the active angle of the exhaust cam mounted on the half-time shaft will be 110 degrees, and, hence, the "exhaust opens" line OB lies 55 degrees ahead of OA. Again, according to Fig. 3, the "inlet opens" and "exhaust opens" lines are 225 degrees apart; hence, in Fig. 9, OB is 112 degrees 30 minutes ahead of OC. The active angle of the inlet cam being 100 degrees, its center line OD is 50 degrees behind OC. This gives us 107 degrees 30 minutes for the angle between the center lines of the inlet and exhaust cams operating the same cylinder. Fig. 10 is a diagrammatic end view of the cam-shaft designed for a four-cylinder engine; it shows the proper arrangement of the four sets of cams that would enable the engine to fire as indicated, *viz.*, cylinders 1, 3, 4 and 2.

Fig. 11 is what may be properly termed the "broadside" view of the cam-shaft. It shows the usual arrangement of cams along the shaft and the supporting bearings. The size of the center journal might be a source of wonder to the uninitiated; the reason for this lies in the fact that when assembling the cam-shaft in the motor, four of the eight cams must pass through the center bearing—hence, the size of the

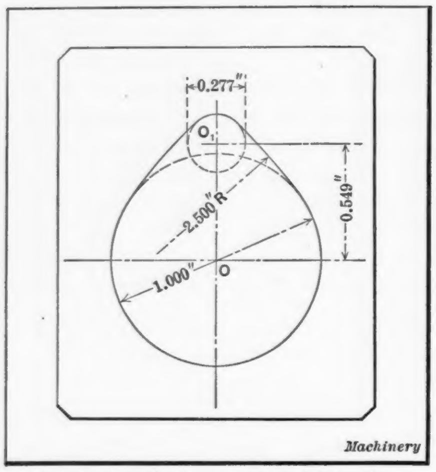


Fig. 8. Templet for the Inlet Master Cam

latter. The cam-shaft shown in Fig. 11 is a one-piece forging, with the cams forged integral with the shaft, which is almost the universal practice today.

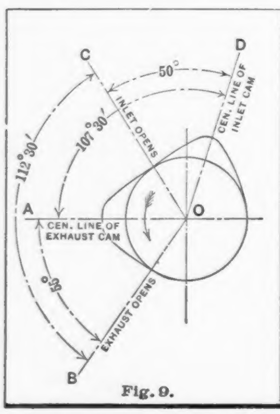
Clearance Angle on the Roller Type of Valve Gear

Fig. 12 is a diagram used for determining the clearance angle on the roller type of valve gear. The proportions are those commonly used, namely, 1 inch diameter for the roller and 1 inch for the base circle of the cam. The cam and its roller are shown in a position where the latter is just on the point of rising, and $OC = 1.000$ inch. When the backlash is closed, the distance between the cam and roller centers is 1.006 inch. The cam, in the meantime, has turned through the angle COC_1 which is our clearance angle a.

$$\cos COC_1 = \frac{OC}{OC_1} = \frac{1.000}{1.006} = 0.994.$$

$$a = 6 \text{ degrees } 15 \text{ minutes.}$$

We shall use this particular valve gear later on for the purpose of comparing it with the mushroom type. Unfortunately, such a comparison cannot be fair to either valve gear.



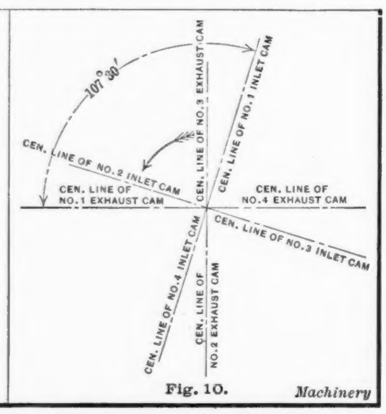


Fig. 9. Method of spacing Inlet and Exhaust Cams

Fig. 10. Diagrammatical End View of a Four-cylinder Engine Cam-shaft

There are so many points of difference between the two types that it is impossible to bring them, figuratively speaking, to the same denominator, as we have done in the preceding series when comparing a tangential and a uniformly accelerated and retarded motion cam operating absolutely the same type of valve gear. Nevertheless, such a comparison will help us to realize what we can expect from either type when built along conventional lines and operating under similar conditions.

Origin of Noises

It has been conclusively proved in the former series that the noise produced by the valve gear is wholly due to the clearance between the valve stem and the valve lifter. The instant this backlash is closed, the valve stem is at rest, while the valve lifter possesses a definite velocity. This state of things results in an impact which is repeated on the down stroke when the velocity of the valve is suddenly checked by the valve seat. Simple observation tends to show that noise increases very rapidly with the speed of the engine, and, hence, with the impact of the various parts of the valve gear. Impact may be defined as the instantaneous transferring of energy from one body to another; the greater the energy stored in the moving parts, the greater the impact, and hence noise, that is produced. From the foregoing it seems reasonable to assume that the noise varies in a direct ratio to the mass of striking parts of the gear and to the square of their velocity.

Mushroom vs. Roller Type

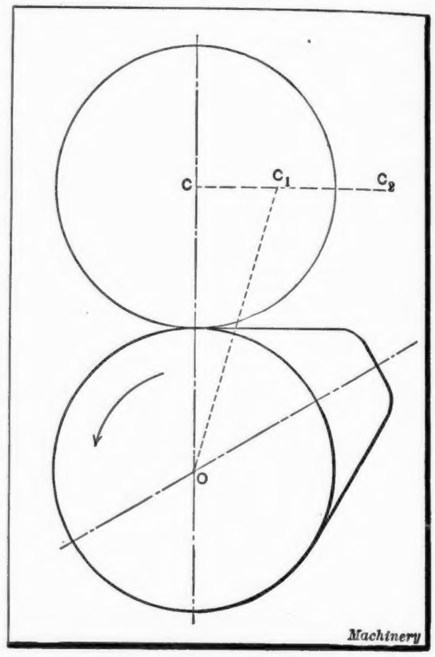


Fig. 12. Relation between the Clearance and the Clearance Angle

Let us assume two similar engines running at the same speed; one equipped with the roller type of valve gear and the other with the mushroom type, but both gears being identical as to their weight, clearance, etc. It is obvious that the quieter of the two engines will be the one whose valve lifters possess the least velocity at the instant the clearance is closed. We need not go into a minute study of the motion of the lifters, as the following simple consideration will help us to decide which of the two types is the noisier, and to what extent. Both lifters start with zero velocity and both rise 0.006 inch before the clearance is closed; but the roller lifter covers this distance in 6 degrees 15 minutes of the cam-shaft angle, whereas the mushroom lifter accomplishes the same result in 4 degrees 30 minutes. With both cam-shafts revolving at the same speed, the mushroom lifter must have greater average velocity in order to cover the same distance as the roller lifter in less time. The average velocity in both cases equals one-half the final velocity, *i. e.*, one-half the velocity at the instant that the impact takes place. While this statement is not strictly true, it is accurate enough for our purposes. Let

S = clearance in inches;

V_1 = final velocity of roller lifter in inches per second;

V_2 = final velocity of mushroom lifter in inches per second;

T_1 = time in seconds corresponding to an angular movement of 6 degrees, 15 minutes of the cam-shaft at any R. P. M. of the engine;

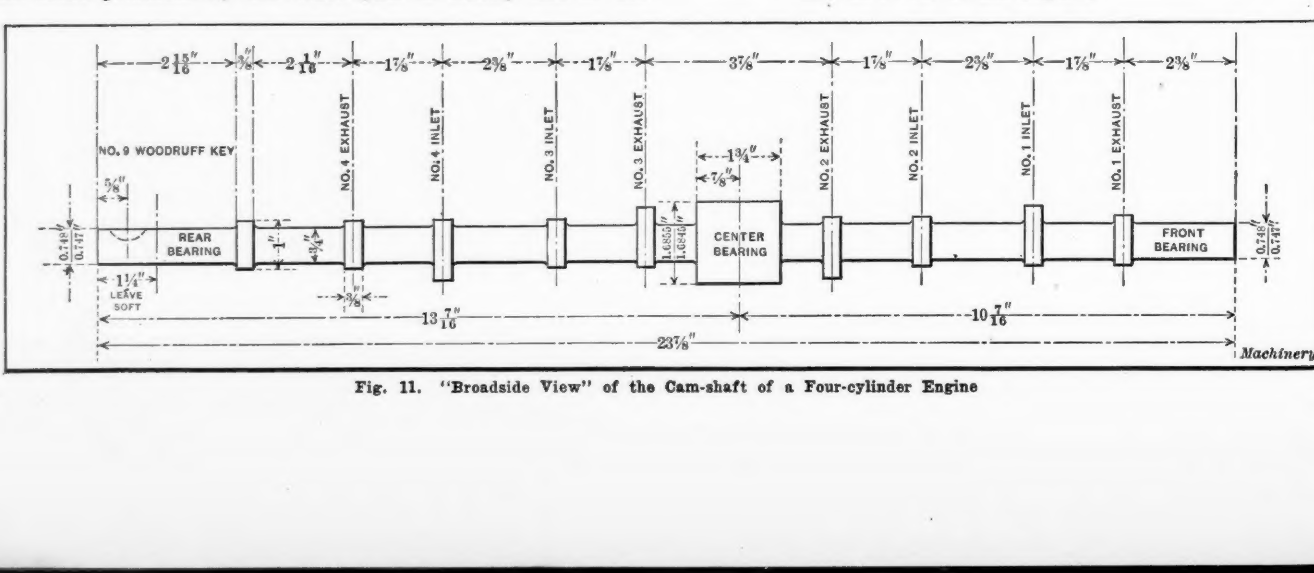


Fig. 11. "Broadside View" of the Cam-shaft of a Four-cylinder Engine

T_2 = time in seconds corresponding to an angular movement of 4 degrees 30 minutes of the cam-shaft angle at the same R. P. M. of the engine.

We then have:

$$S = \tfrac{1}{2} V_1 T_1. \quad (1)$$

$$S = \tfrac{1}{2} V_2 T_2. \quad (2)$$

From (1) and (2)

$$V_1 T_1 = V_2 T_2. \quad (3)$$

$$\frac{V_2}{V_1} = \frac{T_1}{T_2} = \frac{6^\circ\ 15'}{4^\circ\ 30'}. \quad (4)$$

The noise caused by the two lifters is proportional to the squares of their respective velocities. Hence we may write:

$$\frac{\text{Noise of mushroom lifter}}{\text{Noise of roller lifter}} = \frac{V_2^2}{V_1^2} = \left(\frac{6.25}{4.5}\right)^2 = \left(\frac{25}{18}\right)^2 = \frac{625}{324} = 1.93.$$

In other words, the mushroom lifter is almost twice as noisy as its rival. It is obvious that the only way to diminish this noise is to increase the clearance angle, *i. e.*, to shorten the radius of the arc AB, Fig. 4. Our conclusions in regard to the relative amount of noise hold good for the downward stroke of the valve, since the weight of the latter remains unchanged whichever type of lifter is employed; on the upstroke, however, the ratio of noises is considerably lower, owing to the fact that the mushroom lifter usually weighs from 30 to 40 per cent less than the roller type. About two years ago when designing a new engine, the writer discovered for himself the principles underlying quiet operation of valve gears. While recognizing the advantage of the roller type accruing from its lower speed of impact, he selected the mushroom type and by properly proportioning the cam of the latter, obtained some very gratifying results. This engine is known to have run at over 1800 revolutions per minute and its quietness of action was a matter of comment.

About a year ago the writer chanced to see an engine designed to run at not over 1200 revolutions per minute, the speed being controlled by the governor. The mushroom type of valve gear was used first, but the cam was so poorly designed, the clearance angle amounting to only 2 degrees 30 minutes, that the noise was very pronounced and the roller type of gear was eventually substituted in its place. As compared with the first engine, the impact at the same engine speed was in the ratio of:

$$\frac{4.5^2}{2.5^2} = \left(\frac{9}{5}\right)^2 = \frac{81}{25} = \frac{3.24}{1}.$$

The failure on the part of the designers to recognize the principles governing quiet operation of valves is no doubt responsible for the widespread opinion, often voiced by the technical press, that the mushroom type of gear is a noisy one, and that, as such, is unsuitable for rapidly revolving engines. The writer not only takes exception to this statement, but he contends that the mushroom cam and lifter can be designed to work at their best only on high-speed engines. The latter require early opening of the exhaust valves and late closing of the inlet valves, in accordance with principles explained in an article entitled "Timing an Offset Automobile Engine" published in the engineering edition of MACHINERY for February, 1911. In other words, the angle of the valve opening, and, hence, the active angle of the cam, is greater. Now if we turn to Fig. 4, it will be seen that if the active angle of the cam were increased, *i. e.*, if the center line were brought closer to the horizontal line, it would be possible to describe the arc AB with a shorter radius and thereby increase the clearance angle a. A further slight advantage could be secured by decreasing the lift of the cam. Now, short valve lifts coupled with the use of large valves is a condition which becomes more and more desirable as the speed of the engine increases. The slow speed engines, on the other hand, should have shorter valve openings, and, hence, smaller active cam angles—a condition decidedly unfavorable to a large clearance angle, and in such a case either quietness of action or proper timing must be sacrificed. This is the explanation of the apparent paradox that the noisy mushroom type of valve gear can be used to better advantage on high-speed than on comparatively slow engines.

DON'TS FOR BALL BEARING USERS*

BY ARTHUR V. FARR†

Lubrication and Care

Don't run ball bearings without plenty of lubricant. The highly polished surface of the balls and races suffers if run without lubrication.

Don't use any lubricant that is not chemically neutral, *i. e.*, without acid or alkali. For high-speed machinery, use a light machine oil and for heavy loads use a heavy mineral vaseline.

Don't fail to inspect and clean the bearings at regular intervals, flushing out the bearings with a clean supply of gasoline or kerosene whenever lubricant is charged into the bearings. Remember that dust and dirt may have entered the housing and it should be removed to avoid damage to the bearing.

Don't forget to keep the lubricating and drain holes of the housing closed to prevent the leakage of the lubricant or the entrance of dirt.

Don't tamper with the bearings or their housings unless you are compelled to do so for some good reason.

Shipping and Packing

Don't unpack the bearings from the box until you are ready to install them on a machine.

Don't put bearings on the bench or on the floor until you have provided a thoroughly clean surface for them.

Don't ship machines containing ball bearings unless you are certain that no dirt, grit or water can get into the ball bearing housings during the crating or while in transit.

Don't let ball bearings or machines with ball bearings leave the shop without being certain that the bearings and housings are scrupulously clean and filled with lubricant.

Mounting

Don't mount a ball bearing unless the shaft and housings are turned perfectly true, carefully finished and tool marks removed to insure the proper seating of the races. In case split housings are found desirable, great care should be taken to see that the housing sections do not squeeze the bearing.

Don't forget to clean the housing thoroughly with kerosene oil before mounting the bearing.

Don't use a steel hammer directly on the inner race when driving it into position. Light blows struck with a soft metal hammer or wooden mallet are sufficient.

Don't drive the outer race into the housing. This should have a sucking fit and should go into position without force.

Don't forget to provide for shaft deflection unless the bearing itself provides for it, to allow for inaccuracies of mounting and housing.

* * *

DRILLING HOLES IN GLASS

The following is a satisfactory method of drilling holes in glass. Take a piece of straight copper tubing, the outside diameter of which is the size of the hole that it is required to drill. The tubing should have a wall 1/32 inch or more in thickness, depending upon the diameter. The tube is set up in a drill chuck and driven at a speed corresponding to that of a twist drill of the same size. The tube is fed down onto the glass with an intermittent movement, and a mixture of emery and oil is dropped onto the glass at the point where the hole is to be drilled. After a ring has been cut in the glass on one side, the work is turned over and the drilling operation completed from the opposite side. This will prevent chipping the glass when the drill goes through. The copper tubing is soft so that it holds the emery, and as copper is an excellent conductor of heat, it draws the heat away from the glass, preventing it from being cracked. An idea of the rapidity with which holes can be drilled in this way may be gathered from the fact that a 5/16-inch hole can be drilled through an ordinary sheet of window glass in about seven minutes. The title of the article is somewhat misleading because this is really a grinding rather than a drilling operation.

V. P. C.

* For "Don'ts" previously published in MACHINERY, see "Don'ts for Drilling Machine Operators," in the January, 1914, number of MACHINERY and "Don'ts" there referred to.

† Address: S. K. F. Ball Bearing Co., 50 Church St., New York City.

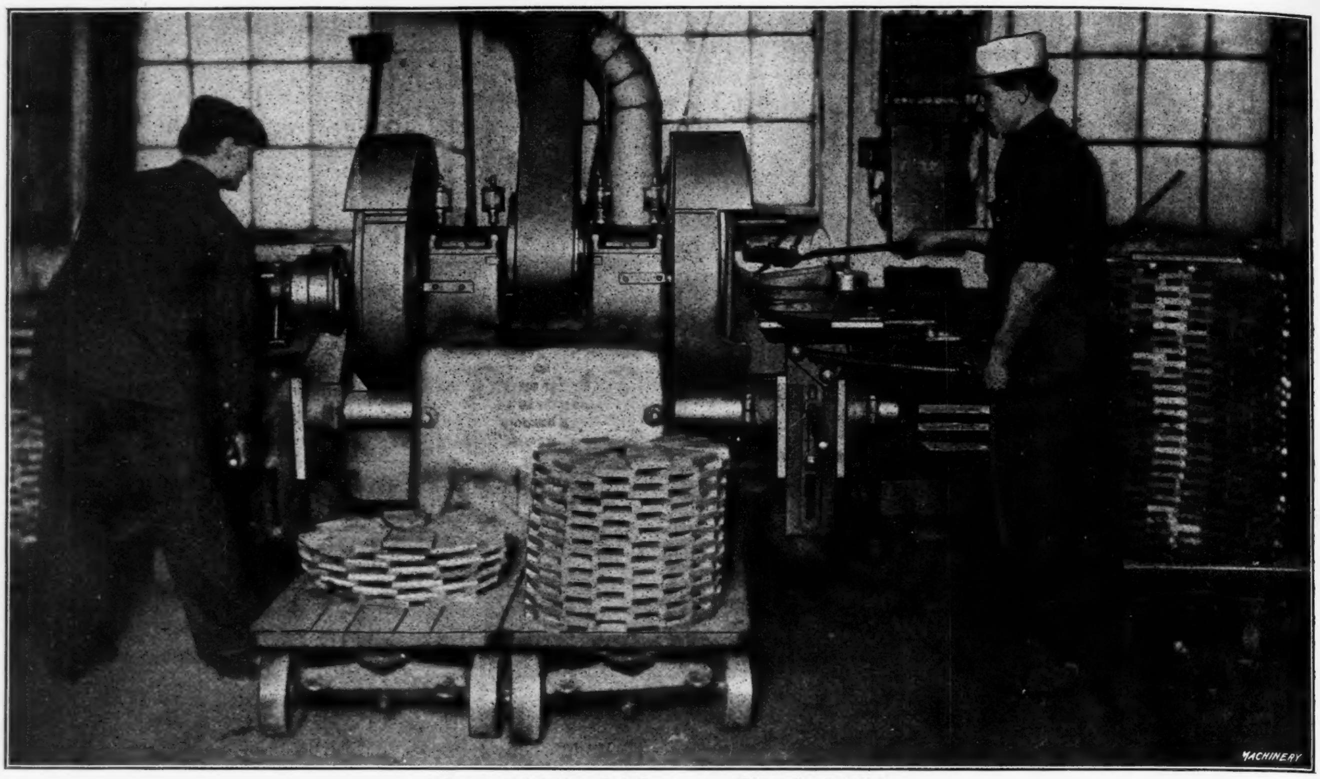


Fig. 1. Finishing Sad Irons on a Ring-wheel Grinder

FINISHING SAD IRONS ON A RING-WHEEL GRINDER

BY CHESTER L. LUCAS*

The machining of castings for sad irons presents difficulties that at first thought are not apparent. There are two general methods of doing this work—milling and grinding. The milling of the faces of flat irons was described in an article in the November, 1912, number of MACHINERY. Through the courtesy of the Simplex Electric Heating Co. of Cambridge, Mass., we are able to describe its method of finishing sad irons by grinding.

The machine on which the grinding is done is a No. 16-24 Besly ring-wheel grinder, shown in Fig. 1. Two men operate the machine, the one at the left working on faces, while the one at the right does the edge grinding. The grinding operation consists of the finishing off of the top face, the lower face, the straight back or heel, as it is called, and the edges.

The operations of grinding the upper and lower faces of the sad iron castings are performed at the left-hand side of the machine. For this purpose, the castings are held on a magnetic chuck shown in Fig. 2. In this illustration the casting is shown in the chuck ready for the finishing of the lower face. The upper face is similar, except that there is only a narrow edge to be cleaned off. The operator stands, as may be seen in this illustration and in Fig. 1, and with the casting rotating with the magnetic chuck, feeds the carriage, chuck and work to the wheel with his left hand, while with the right hand the grinding carriage is swung on its horizontal axis across the face of the ring grinding wheel. This combined rotary and lateral movement rapidly faces off the casting. An idea of the speed with which the face grinding is done may be obtained when it is stated that the upper face is ground at the rate of one hundred and twenty castings per hour and the lower face at the rate of seventy per hour. The next operation consists of grinding the heel or back of the iron. This is a simple grinding operation and is performed on two castings at a time. The heels of one hundred and twenty sad iron castings are ground per hour.

We now come to the most interesting part of this grinding operation—that of finishing the edge. By referring to Fig. 3, it will be seen that the edge of the sad iron combines a straight section near the heel, a long radius section immediately following, and at the point a section that conforms to a much shorter radius. The opposite side of the iron is, of course, the reverse of this. This operation is shown being performed on the right-hand side of the machine illustrated in Fig. 1. The special fixture is mounted on a table of the ring-wheel grinder after the manner shown in Fig. 3. It is held on the grinding machine table and the table swings on the horizontal axis as shown. At the front is a handle to facilitate swinging the fixture and at the rear is a weight to counterbalance it. The grinding of the edge consists of finishing the straight section near the heel, then grinding the long radius section adjacent and finishing up with the short radius

* Associate Editor of MACHINERY.

Fig. 2. Rotary Magnetic Chuck for Face Grinding Use

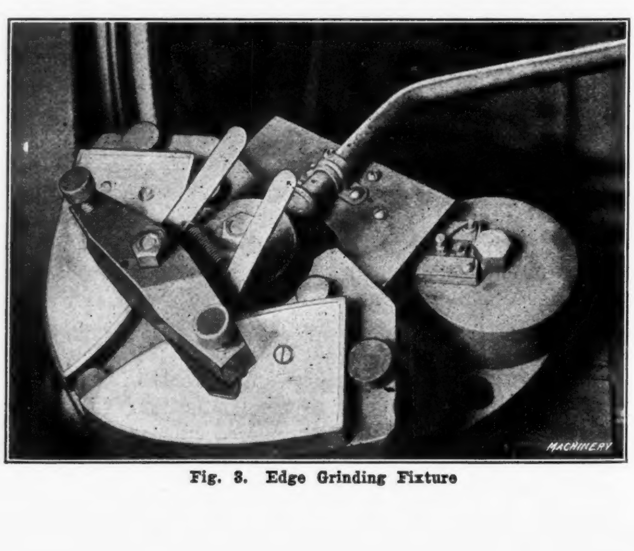


Fig. 3. Edge Grinding Fixture

near the point. By swiveling the fixture with the operating handle, the different sections of the edges are successively ground.

Some conception of the rapidity with which this grinding is done may be obtained from the production figures: Heel grinding, 120 castings per hour; top face grinding, 120 castings per hour; bottom face grinding, 70 castings per hour; edge grinding, 70 castings per hour.

* * *

COMPENSATING FOR ANGULARITY IN FITTING TAPER GIBS AND SLIDES

BY HAROLD F. PENNEY*

Everyone who has undertaken to fit taper gibs to their slides knows that whenever the slide is angular or dovetailed the taper on the slide is not the same as that to which the gib was originally planed. Possibly each mechanic has his own method for compensating for the angularity. The writer, with no claim of originality, has worked out a table to be used in connection with a common method that has

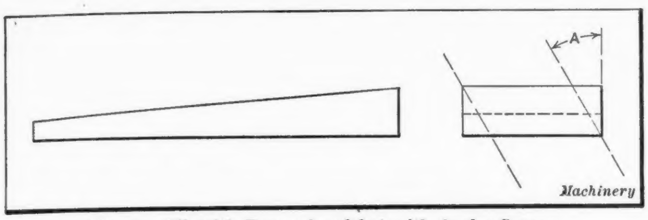


Fig. 1. Gib with Taper planed but with Angles Square

been found to give satisfactory results and believes that this may be of interest and value to others. While the table covers the general range of practice, its derivation is also included to accommodate any special work.

In following this method the gib is first planed to the proper dimensions including the taper, but with the angles square, as shown in full lines in Fig. 1. The corners are then planed off to give the desired angle A as shown by the dash lines. The slide is next planed, one side being kept straight or parallel and the other tapered to agree with the gib. The amount of taper is found from the table by following across under the heading "Original Taper of Gib," through the column headed "Angle of Slide," to the column headed "Taper of Slide." For example, if we were cutting a 40-degree dovetail slide having a gib tapered 1/8 inch per foot, we should find the taper of the slide to be 0.163 inch per foot. The table also gives the angle corresponding to the taper in inches per foot at which the slide should be set.

This method provides a constant means of checking the setting, for as soon as the roughing cut has been taken on the slide the gib can be tried in place. If the setting is correct the dimensions M and N, Fig. 2, which shows the gib in place, will be equal. If they are not equal, adjustment can be made and the cut continued until the readings agree and are of the desired value.

The values for the table were found as follows: Referring to Fig. 3, O represents the original taper at which the gib was cut; and F is the effective taper at which the gib acts, due to the angle A of the slide. From the relation of the parts of right angle triangles:

$$F = \sec A \times O.$$

* Address: Care of Hartford Public High School, Hartford, Conn.

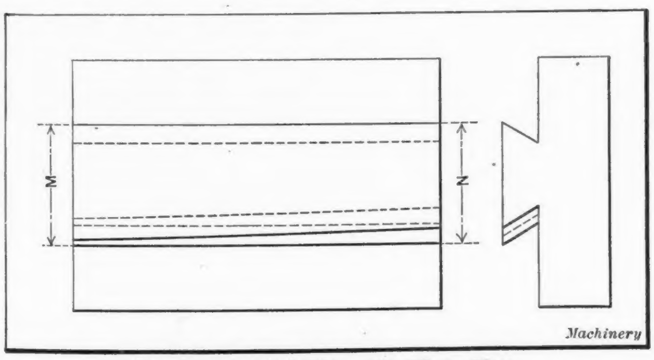


Fig. 2. Dovetailed Slide with Gib in Place

Substituting in the case already used as an example:

$$F = \sec 40 \text{ degrees} \times 0.125 = 1.3054 \times 0.125 = 0.163.$$

The angle corresponding to the taper is found from the following simple equation:

Tangent of taper angle = inches of taper per foot ÷ 12.

Continuing with the same example:

$\tan A = 0.163 \div 12 = 0.01360.$

Looking up this value in a table of functions we find:

$A = 47$ minutes.

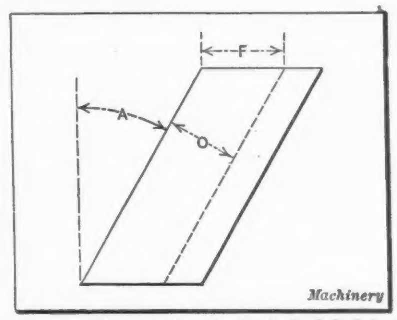


Fig. 3. Diagram showing Method of deriving Required Taper for the Slide

While no reference has been made to a machine other than a planer, it is apparent that the method and tables are just as applicable to the milling machine, or to any other machine which could be used for this type of work.

* * *

Several of the largest representative American manufacturing plants in full operation are to be taken to South America by means of the "movies" in order that the merchants there may see the advanced method of making American goods. By this method the makers of road-building machines, conveyors, laundry supplies, and other large machines will show their wares in full operation without the necessity of carrying the actual machinery. Accompanying the expedition will be a party of some thirty American salesmen who will represent the exhibition from sixty manufacturers. The *Kroonland*, upon which the exhibit is to be carried, will

TAPERS FOR DOVETAILED SLIDES CORRESPONDING TO VARIOUS GIB TAPERS

Original Taper of Gib, Inches per Foot	Angle of Slide, Degrees	Taper of Slide, Inches per Foot	Corresponding Angle, Degrees	Corresponding Angle, Minutes
1/8	15	0.129		37
	30	0.144		41
	40	0.163		47
	45	0.177		51
3/16	15	0.194		56
	30	0.217	1	2
	40	0.245	1	10
	45	0.265	1	16
1/4	15	0.259	1	14
	30	0.289	1	23
	40	0.326	1	34
	45	0.354	1	41
5/16	15	0.324	1	33
	30	0.361	1	44
	40	0.408	1	57
	45	0.442	2	6
3/8	15	0.388	1	51
	30	0.433	2	4
	40	0.490	2	20
	45	0.530	2	32
1/2	15	0.518	2	28
	30	0.577	2	45
	40	0.653	3	7
	45	0.706	3	22

Machinery

visit about twenty of the leading South American cities. This will be the first time that a foreign trade display has been made in this way.—*Moving Picture World.*

* * *

The value of the imports of machinery into Norway, in 1913, amounted to nearly $7,500,000, showing a very rapid increase during the last few years. Seven years ago, the imports amounted to only $3,500,000 a year. The total value of machinery and tools imported into Norway during the last six years amounts to about $40,000,000. The Scandinavian countries have undergone a great industrial development during the past ten years.

THE TRUING DIAMOND

BY DAVID D. MACLAUGHLIN*

Much has been written of late regarding truing diamonds for dressing grinding wheels, their selection and the excessive cost of upkeep, etc. While the quality of the stones used for this purpose varies, it will generally be found that with proper handling the length of service which a truing diamond will give is in proportion to the price paid, as most companies handling these stones grade them according to weight, shape and quality. A stone costing $25 ought to show less fracture than one costing say $10. The high priced stone should have a smooth unbroken surface, and be of such proportions that it will withstand shock without breaking. The cheaper stones are usually flat or elongated and show considerable fracture to the naked eye. They should be used only on light work, and will last longer for hand-truing than when fixed on a toolpost or slide-rest fixture. That there are causes, other than poor quality stones, which contribute to make this part of the grinding business troublesome and expensive, I shall try to show. While the quality of the diamond plays a very important part, the poorest stone may be used in such a way that it will give longer service than a good quality of stone improperly handled.

Setting the Diamond

It is necessary, of course, that the truing diamond be set in a suitable holder, and on this operation of setting depends, to a great extent, the length of service which the diamond will give. The usual method is as follows: A hole a little larger than the diamond is drilled in a piece of soft steel or copper of suitable shape to fit the holder supplied with the machine. The stone is then placed in the hole thus provided and held in place by peening the metal close around it; in some cases the piece of metal used is heated to a red heat so that it may be more easily closed around the diamond. That a diamond set in this way may survive the ordeal, goes without question; but unless the greatest care is used in the operation, the stone is only worth so much salvage in the form of diamond dust. Unfortunately, the damage done very often goes unnoticed until the truing diamond reaches the grinding machine operator, who proceeds to true up his wheel. Sooner or later he finds that the diamond is fractured but, fearing that he may have forced it in the operation of truing, keeps on using the stone in the hope that it will hang together. The result is inevitable, however—piece after piece crumbles away until what remains looks like so much granulated sugar. The operator then goes to the head of his department with a long face and a report that the diamond was "soft," "seemed to crumble away," etc., etc. While a perfectly good diamond may easily be ruined in use, the damage, in nine cases out of ten, is caused by improper setting.

One of the points which is often overlooked in setting a diamond by the above method is the manner in which the stone is actually held in its setting. Consider that the truing-diamond is a rough shaped, natural stone with corners or projections, and with flat and concave or convex portions on its surface. Then think of what is likely to happen when this stone is placed in a round hole, bored so that the stone is a loose fit in some kind of metal holder, and the metal closed round the stone haphazard, leaving one corner projecting. On account of the uneven or eccentric periphery of the wheel being trued, the diamond is subjected to a series of knocks in rapid succession, which tend to cause it to revolve or turn in its setting. It is prevented from turning by the projections holding onto the metal in which it is encased. The projecting points, therefore, act like so many levers tending to pry the stone apart. The life of the stone—usually very short in a setting of this kind—will depend greatly on the lay of the grain in relation to these corners.

To avoid the risk of breakage, it is essential that the truing diamond be set in such a manner that the *whole surface of the stone*, except the point exposed, *is in contact with the metal in which it is embedded.* This may be accomplished in several ways as follows: (1.) Drill a hole in a piece of copper bar to a sufficient depth to leave the diamond just exposed, using a drill a little smaller than the diamond; and then with the aid of a small set of chisels comprising a 1/4-inch diamond point chisel, a 1/4-inch cross-cut chisel, and a 1/4-inch round nose chisel, proceed to shape the hole to conform to the shape of the diamond set in position to obtain the best cutting point. Tap the stone very gently in place, using a small block of wood and hammer, and complete the operation by tamping the copper close around the exposed point with a hammer and center punch or nail-set. The greatest care should be used so that the diamond is not subjected to shock, either from the tools coming in contact with it or the copper being tamped against it with undue pressure. (2.) Another method of setting, which has many advantages without the risks attached to the method just described, has been practised with success and is carried out as follows. Drill a hole in a soft steel holder about 1/8 inch larger in diameter than the diamond, and to a sufficient depth so that the cutting point will just show. Undercut the hole so that the setting will dovetail into the holder and complete the operation by melting around the stone in place enough granulated brazing spelter to run flush with the cutting point. For this part of the setting, a blow-pipe is required which will produce a flame capable of melting the spelter. This method has the advantage that the diamond may easily be taken out by melting the setting, when it is desired to reset the stone to obtain a new cutting point, which is a very important advantage, as the stone will last much longer if reset when it is found that the tool is working unsatisfactorily. Also, a diamond set in this way, with its whole surface in contact with the material in which it is embedded, will better withstand the strain to which it is subjected than if set by any other method.

Of the several clamp holders which are sometimes recommended, whereby a diamond is held in a miniature vise, I have nothing to say in this article except that I leave them to the readers' judgment in the light of the preceding suggestions. As in setting the diamond, so in using it, the greatest care should be exercised so that the stone is not abused; the operator should see that the diamond is passed across the work so that it will cut without excessive pressure, and when possible, a great saving may be effected by using a Huntingdon dresser to roughly true the grinding wheel, only using the diamond for a finishing cut. For this purpose, a special detachable rest would be necessary in a great many cases, but the saving would make it worth while. When truing wheels made by the "elastic" process, use a diamond only. A suggestion was made by the writer of a recent article on this subject, that in the near future an artificial stone may be produced as good as the diamond or nearly so, and much cheaper. I might point out that as soon as something of this kind is discovered, the grinding wheel manufacturer who is ever ready to improve his product will pounce on the new abrasive and proceed to make it up into grinding wheels, so that the last state of the grinding man is worse than the first. It may be a long time before anything is found to equal the diamond for truing the grinding wheel. In the meantime give the diamond a square deal.

* Address: American Emery Wheel Works, Providence, R. I.

* * *

The foreman of a repair shop tells the following story in a contemporary: "The other day a man called and wanted a job, saying that he was quite experienced on repair work and had worked in many small repair shops. I put him to work chipping the flanges of a steam chest. He started out fine, but at four o'clock I found him sitting on a bench by the side of his job comfortably smoking. I asked why he was doing this, as smoking was not allowed in the shop. He replied: 'I've always been in the habit of having a smoke at four o'clock in the afternoon, and if so be that you don't like it, you can pay me off.' I did as he requested, but after he had gone, on looking up his job I found that he had knocked a corner of the flange off from one hole to the next, necessitating the replacement of the entire steam chest." This method of getting laid off and drawing the pay before the damage is detected seems more ingenious than honest.

BAD EFFECTS OF SHAFT STRAIGHTENING

BY L. LANGHAAR*

It is frequently necessary in building machinery to straighten shafts which have sprung during the process of manufacture. The company with which the writer is associated is engaged in building a multiple spindle turret machine in which great accuracy and durability are essential. The spindles in these machines are made with standard taper holes, and each spindle slides in its bearings, as well as rotating in them. The taper hole must be exactly central and in accurate alignment. In making these spindles it was decided not to resort to the use of a straightening press, but to machine them to remove any inaccuracy produced in hardening. Needless to say, this makes a considerable increase in the cost of production, as compared with the use of the time-honored straightening press, as it involves several different turning operations before grinding. It is felt, however, that a number of important improvements are obtained.

The chemist and the metallurgist have shown that steel consists of iron and iron compounds, each minute particle of which is held to neighboring particles by a force known as "cohesion." Like every elastic material, a bar of steel exhibits certain well-defined properties when loaded. Up to a certain limit the bar will return to its original form when the load is removed, this statement being based on the assumption that a load—however small—will cause a certain deflection of the bar. This is a proved fact. The limit of loading beyond which the bar fails to return to its original position is generally known as the "elastic limit," but our German friends very appropriately call it the "proportional limit." The reason for this name is that up to the proportional limit the deflection and the load are proportional to each other. Beyond the elastic limit the load and the deflection are no longer proportional, and the deflection becomes permanent, a "permanent set" having been produced in the bar. The strength of the steel is also found to be permanently reduced after it has been loaded beyond the elastic limit. The straightening press would be useless unless it strained a shaft beyond the elastic limit, and, therefore, it is reasonable to assume that the strength of a shaft which has been straightened cold in a press has been reduced.

To further explain this point it may be stated that the elastic limit is the point at which cohesion between the iron particles begins to give way, and this weakening of the cohesive force cannot be overcome by subsequent heat-treatment. It makes no difference whether the straightening is done before or after the heat-treatment to which the shaft is subjected; the steel is permanently weakened in either case. Heat-treatment generally has the effect of springing a shaft, but if this deformation is to be removed without a reduction of strength, the use of a straightening press should never be resorted to. The deformation should be overcome by grinding the shaft. A rule-of-thumb mechanic was recently heard boasting how he had repaired an automobile. The axle shaft, which was made of really high-grade chrome-nickel steel, had broken, and this man felt that particular credit was due him because he had replaced it with a shaft made of cold-rolled steel, which had already been in service longer than the original shaft. From this experience he inferred that what he styled "new fangled" ideas were no good.

The writer happens to have accurate personal knowledge of the construction of the automobile in question. The best materials and the highest grade of workmanship are used. The greatest care is taken in all machining operations, and heat-treatment is conducted along the most approved lines. However, the use of a straightening press is resorted to after the axle shafts are heat-treated. Those that do not show visible cracks after straightening are passed by the inspection department, when, as a matter of fact, many of them are in a state of incipient rupture. There is not one scientifically educated man holding a responsible position in this particular automobile factory, and it is perhaps worthy of mention that the company is now in its second receivership. There are doubtless a number of contributory causes for this state of affairs, but the little trick of straightening shafts in a press may be one of them. The car manufactured by this company is noted for its excessive weight, and it has apparently been found necessary to use a heavier construction than that employed in many other cars of the same power in order to obtain the required strength.

In the case of machine tools, a much heavier construction is necessary than that required in automobiles. Machine tools demand exceptional rigidity in order to turn out a product which is sufficiently accurate to meet modern requirements, and this means that the parts must be of ample strength. The following argument may be advanced against what has been said in regard to the straightening of spindles with taper holes: If the spindles are straightened by grinding, the taper hole will still point in the direction in which it was sprung, and, as a consequence, the hole will be out of alignment with the outside of the spindle that was finished by grinding. To avoid this difficulty, we use an alloy steel which has been previously heat-treated so that it is as tough as it is possible for it to be and still enable the machining operations to be performed by high-speed steel tools. Several adjustments and turning operations in the lathe make the taper hole perfectly true with the turned and splined spindle, and no subsequent heat-treatment is resorted to which will affect the accuracy of the spindle. The final grinding is merely for the purpose of finishing the spindle to the exact size.

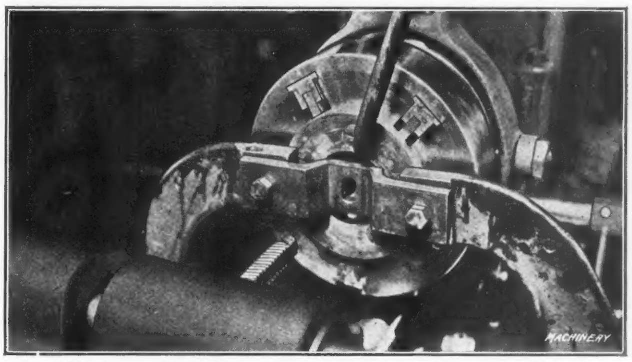
To obtain the best results from heavy-duty machinery, the writer believes that the straightening press should be used very cautiously and only on the advice of a competent engineer, who will not be likely to recommend it for parts that are subjected to severe stresses. It appears likely that many so-called mysterious cases of the failure of shafts may be traced to this cause. At all events, it is certain that, other things being equal, shafts which have been straightened under a press cannot equal in strength and driving power those which have been straightened by some more suitable method.

* Address: 28 Maple Ave., Danbury, Conn.

* * *

CUTTING PIPE WRENCH THREADS ON BOLT CUTTER

The Acme Machinery Co., Cleveland, Ohio, is using a five-chaser die-head with a special guide for cutting threads on pipe wrench movable jaws of the Stillson type. The accompanying illustration shows the die-head, the guide for the wrench jaw and the wrench jaw gripped in the vise. With five chasers and the guide which holds the part to be threaded closely, it has been found possible to cut very smooth and accurate threads even though the part is of approximately rectangular cross-section.



Five-chaser Die-head and Guide used for cutting Threads on Pipe Wrench Jaws

The company is cutting all sizes of jaws from ⅜ inch to 2 inches on an Acme No. 2 machine. Each size requires a different chuck for holding the jaw and a different guide. The object of the guide is to hold the shank rigidly while it is being threaded, and five jaws are used instead of four in order that one die may always be working. This overcomes any chance of twisting the shank while threading. About five wrenches per minute may be threaded with this rig.

F. L. H.

* * *

Don't forget that if a sleeve collet slips around in the spindle or a drill slips around in the sleeve collet, the surface of the tapers have become nicked and need smoothing off.

FORMING TOOLS FOR GEAR CUTTERS*

A SIMPLE METHOD OF MAKING A FORMING TOOL ON THE UNIVERSAL MILLING ATTACHMENT

BY JOHN EDGAR†

THE making of a forming tool for forming gear cutters is a job that a great number of shop men would, no doubt, like to tackle; but they would not know just how to go about it if the problem was put up to them. Making forming tools for this purpose is not work that is frequently given to the toolmaker, but there are some instances when a special gear cutter is wanted and lack of time prevents having it made by the cutter manufacturer, who is not always very prompt in filling such orders. The ordinary practice is to lay out the tooth curve full size or several times enlarged, and then make master tools to this drawing, by which the formed tool is planed. Following this method, it is necessary to make a special master planing tool for each side of the tooth and planing tools for the curves at the bottom; and this coupled with the method of using the tools and making the necessary corrections for the distortion due to the angle

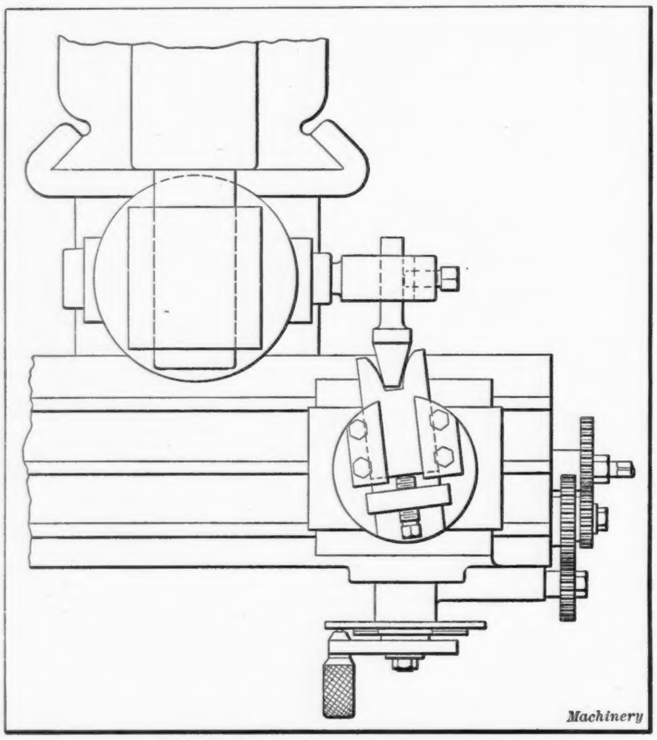


Fig. 1. Milling Machine set up to generate Forming Tool for Gear Cutters with a Rack-shaped Tool

in which each tool is set in planing, are all likely to lead to inaccuracies in the tooth curve, making the results anything but satisfactory. It is the intention to show in this article that all these master tools and complicated settings, and the "mysterious nothings" that hang around the job and make it appear out of the ordinary are unnecessary to the successful production of a forming tool. By the method to be described all the multiplied inaccuracies incident to copying from this original draft are omitted. This method consists of generating the forming tool direct without any intermediate steps, and by mechanical means that alone determine the shape of the tooth curve, so that a correct involute curve is obtained without any approximations whatever.

Probably the greatest drawback to the first method of procedure referred to is the necessity of making the original drawing of the tooth curve, there being so many methods in use that are mere approximations. Such methods are all well enough for the purpose of representing gear teeth on a drawing, but if it is attempted to make the teeth themselves to these layouts, trouble is more than likely to put in an appearance with a loud protest. Almost any toolmaker worthy of the name can produce a tool very close to the original

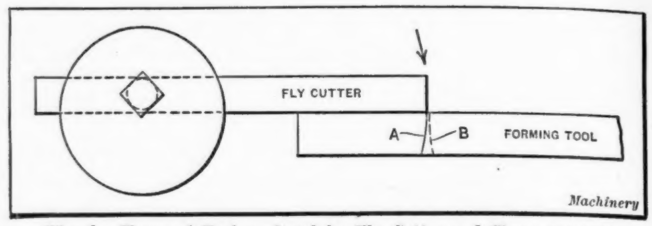


Fig. 2. Shape of Tool produced by Fly Cutter and Shape required for Clearance

curve; but the proposition of getting exactly the original curve is a job that must be left to some mechanical means if we are to get the closest possible degree of accuracy. This means is now to be found in the toolroom of any pretentions, and is the trusty universal milling machine. For the operation of generating the tool, a universal milling attachment is required, which may make the use of the method impossible in some cases; but these attachments are now commonly found in the toolroom in connection with the milling machine. There are two methods by which the tool may be made, that are to be described in the following. (1) By using a rack tooth shaped fly tool or cutter. (2) By using a straight faced tool or plain side mill of narrow face, and setting the axis of the cutter spindle and the ways of the table at the angle of the pressure line.

Fig. 1 shows the set-up of the machine for using the rack-shaped fly cutter. Here we have the forming tool clamped in the special chuck held in the spindle of the dividing head, which is set in the vertical position. The head is shown set up with the change gears as in spiral cutting, the pitch for which the gears are chosen being equal to the circumference of the pitch circle. The universal spindle of the attachment is set at right angles to the axis of the main spindle and parallel to the direction in which the table travels. Set up in this manner, the machine is ready to generate the involute sides of the forming tool, when the fly cutter is shaped like the tooth of a rack of the same pitch. The process is similar to that used in some way in all generating machines. By setting the top of the forming tool blank at the height of the axis of the cutter spindle, and the fly cutter so that the cutting plane passes through the center of the cutter spindle, next adjusting the fly cutter to produce a gash of the proper depth, and then starting the machine and throwing in the feed to the table, we can generate the tooth space shown. This space is of the correct shape at the top of the tool only, as the angle of the fly cutter with the top of the forming tool affects the shape at all other positions deeper in the tool. This is obviously the reverse of the generating method described in my article in the May number of MACHINERY, in relation to the generating of hob tooth shapes. A tool made

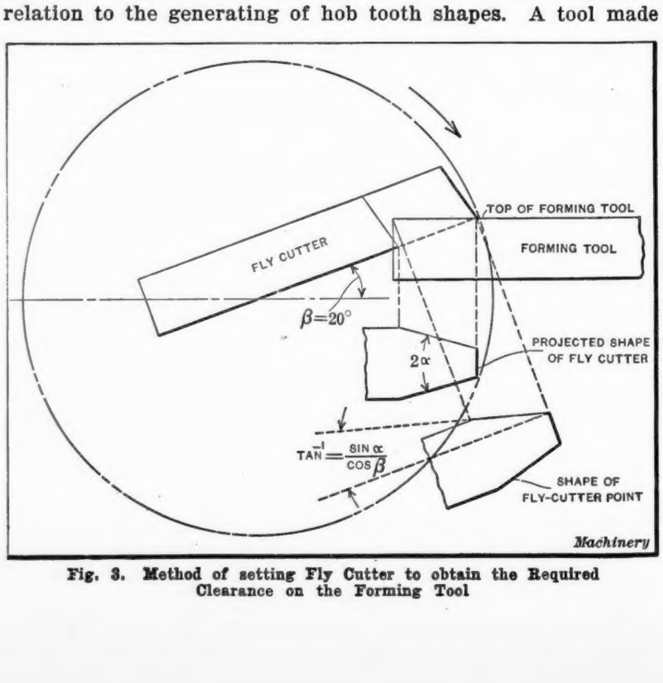


Fig. 3. Method of setting Fly Cutter to obtain the Required Clearance on the Forming Tool

* For additional information on forming cutters and allied subjects published in MACHINERY, see also "Making a Forming Tool for a Gear Cutter," by Earle Buckingham, May, 1914; "Making Formed Cutters," by F. B. Jacobs, April, 1914, and other articles there referred to.

† Address: 61 Bruce Ave., Windsor, Ontario, Canada.

in this manner would appear as shown at *A* in Fig. 2, and to make it of use as a forming tool it must be relieved up to the top for clearance. This can be done by filing or other means, so that the finished tool would have the 20-degree clearance shown dotted at *B*, extending all around the form. With the fly cutter made to close dimensions, the space generated will be of the correct width at the pitch line and to depth; and a forming tool made with it would likewise be of the correct size in relation to thickness and depth.

The necessity for relieving the tool after generating may be eliminated by setting the fly tool as shown in Fig. 3, 20 degrees being chosen as giving plenty of clearance for the tool in the forming and backing off of the cutter. If the cutter teeth are to be given more than the ordinary amount of relief, the angle should be increased. With the use of the fly cutter in this position, a correction will have to be made to counteract the angle at which it is set. This is done by making the angle of the fly cutter such that the angle on a line parallel with the top of the forming tool will be twice the pressure angle. The corrected angle of the side of the fly cutter may be found by the formula:

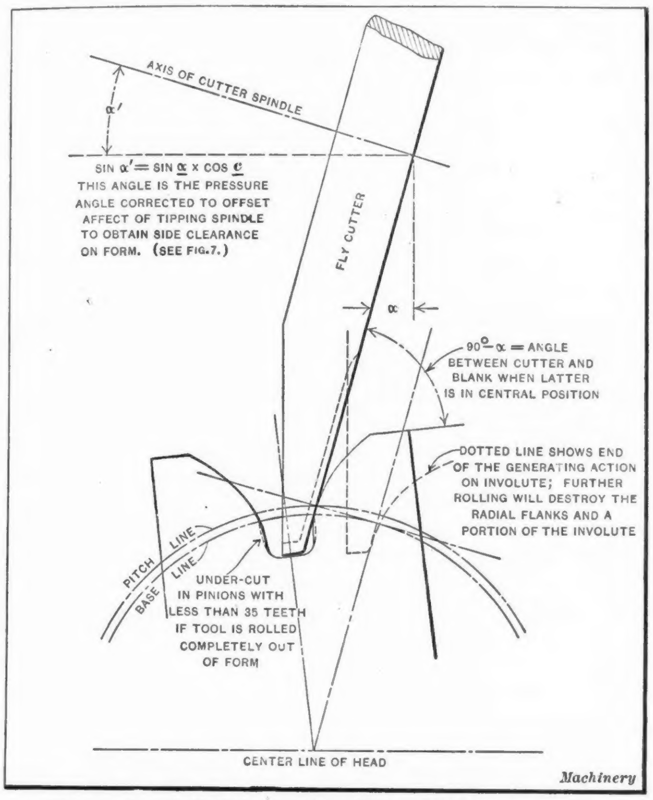


Fig. 4. Second Method of setting Milling Machine to generate Forming Tool for Gear Cutters with a Straight Fly Cutter

$$\text{Tangent of angle of side of fly cutter} = \frac{\sin \alpha}{\cos \beta}$$

where α = pressure angle and β = clearance angle.

The included angle of the tool is twice the angle of the side, and the height at which the forming tool is set above the center of the cutter spindle is found by trial, by setting the fly cutter as shown in Fig. 3 and bringing the forming tool to the height of the tip of the fly cutter. This height is, of course, dependent on the radius of the circle swept out by the fly cutter. The fly cutter should be set to sweep out as large a circle as possible, to give the least possible amount of concavity to the forming tool. The shape generated by the fly cutter is nearly correct throughout the thickness of the forming tool when the latter is thin as compared to the sweep of the fly cutter; and the forming tool can be sharpened by grinding across the top face without greatly changing its form. The clearance of the forming tool decreases as it is worn by sharpening; but the amount of use to which an emergency tool is put will not usually call for much grinding. The clearance, as produced in the case of the fly cutter set according to the preceding instructions, is not adapted to work that requires side relief, as in the case of small numbers of teeth nor for bevel gear cutters.

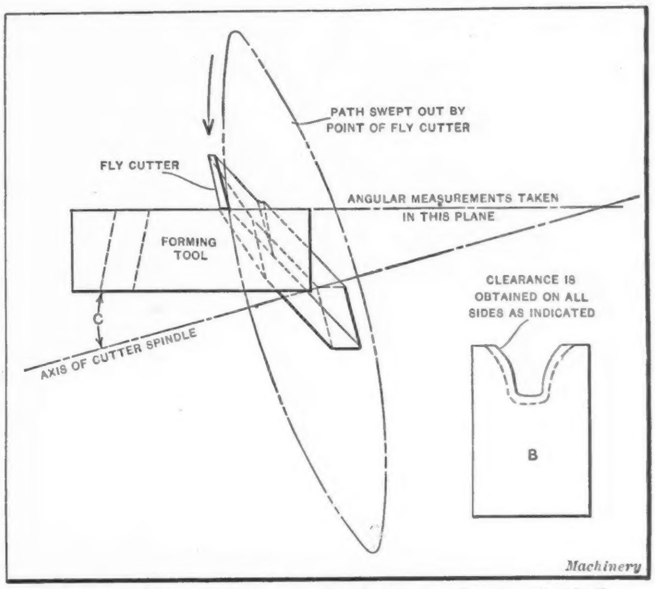


Fig. 5. Method of setting the Fly Cutter to give the Required Side Clearance to the Forming Cutter

The second method of generating the forming tool is shown in Fig. 4. The machine is set in the same manner as in the case shown in Fig. 1, with the exception of the angle between the cutter spindle and the table. This can be obtained by either setting the cutter spindle to the angle of the pressure line, after making a correction to counteract for the effect of the clearance angle, or by swinging the table to that angle—whichever is the most convenient. The cutting edge of the tool is at right angles to the axis of the cutter spindle, which makes it necessary to make a separate setting for each side of the form—setting a tool of the other hand to the opposite angle. The clearance in this case is obtained by setting the fly cutter as in Fig. 3, and giving the cutter spindle an upward tilt—shown by the angle *C* in Fig. 5—that is desired for side clearance. This may be the same as the radial relief or it may be less, a 10-degree angle being plenty for most cases. This sidewise setting is shown in Fig. 5; and the effect of the setting on the clearance is shown at *B*, in the same illustration. In generating with the fly cutter to sweep out the forming tool at this compound angle, the side of the forming tool is not straight as might be surmised, but is warped as in the case of spiral gears. This does not affect the shape of the tool materially, but it increases the clearance angle as the tool is worn down. There is no need of any other correction being made in this case, as the tool sweeps out a plane in which the side of a rack tooth would lie.

The amount of roll to give the forming tool is an important point in the case of pinions with less than 30 or 35 teeth, as it is in these smaller numbers that the teeth of the generated gear are undercut and it is obvious that a milling cutter will not mill undercut teeth. These pinions are made with radial flanked teeth, having that portion of each tooth that is below the base line radial. A full generated forming tool for the

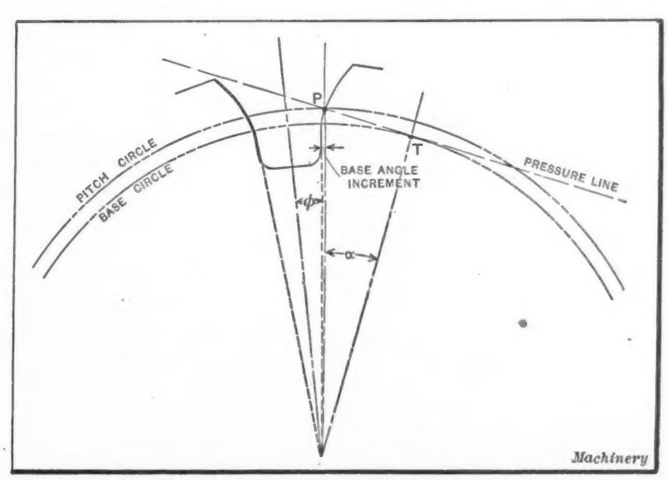


Fig. 6. Diagram illustrating Derivation of Formula for the Value of the Angle ϕ

cutter for a twelve tooth pinion would be undercut in the manner shown in Fig. 4 by the dotted lines, while the full lines show the proper radial flanked form. This radial flank is obtained by stopping the roll at the point where the fly cutter becomes normal or at right angles to the base line in the dotted position. A convenient way in which this may be done is to find the angle of the radial tooth space, which can be done as follows: In Fig. 6 we first draw the pitch circle and then the pressure line intersecting it at P; and tangent to this pressure line draw the base circle, the point of tangency being T. Next draw the lines intersecting the point of tangency and the point P, and passing through the center of the pitch circle. The length of the pressure line between the points P and T is given by the formula:

$$\text{Length} = \tfrac{1}{2} \sin \alpha \times \text{pitch diameter.}$$

This length projected on the base circle locates the end of the involute curve at the base circle and its distance from the point T. The angle embraced between these two points is given by the following formula:

$$\text{Included angle} = \frac{360 \times \sin \alpha \times \text{pitch diameter}}{2 \times \text{circumference of base circle}} = \frac{360 \sin \alpha}{6.2832 \cos \alpha}.$$

The angle included between the points P and T is the pressure angle α, which subtracted from the preceding result, gives what we will term the "base angle increment." The angle included between the pitch points of the teeth on the opposite sides of the space is $360 \div 2N$, and the base angle increment subtracted from one-half of this gives the angle ϕ which the radial flank makes with the center line of the space. Expressed as a formula this is:

$$\phi = \frac{360}{4N} - \left(\frac{360 \sin \alpha}{6.2832 \cos \alpha} - \alpha\right) \text{ degrees}$$

where N is number of teeth in gear.

Having found the angle of the flank with the center of the tooth space, the rolling of the forming tool is stopped when the angle between the side of the tool blank and the fly cutter becomes equal to the difference between the pressure angle α and the center angle ϕ of the radial space, as shown in Fig. 7. This may be done by stopping the feed when the head has traveled toward the fly cutter an amount equal to

$$\frac{\left[\left(\frac{360}{4N} + \alpha\right) - \phi\right] \times \text{pitch circumference}}{360}$$

from the central position in Fig. 4.

In making the forming tool blank, care should be taken to have the end planed square with the sides and the chuck should also be true. The space should be roughed out to depth, leaving sufficient stock for forming; and when the fly cutter is sunk to depth for the generating operation, the side of the blank should be at right angles with the line of travel of the table. It should also be at an angle with the cutting plane of the fly cutter, measured parallel with the top of the forming tool, equal to the complement of the pressure angle or of $90 - \alpha$, which in the case of the $14\frac{1}{2}$-degree tooth is $75\frac{1}{2}$ degrees. After the fly cutter has been sunk to depth, the tool should be cleared of the gash and the table moved with the gears in mesh so as to bring the fly cutter to the extreme left of the central position in Fig. 4, before the generating is commenced, so as to form the involute curve at the extreme point of the tool. When the gears to mesh are extremes as regards the number of teeth, the points of the teeth of the larger gear will have to be slightly relieved to avoid interference, as shown dotted in Fig. 8, the amount of the relief being a matter on which it is difficult to give a simple rule. The most certain and practical method is to generate templets while the machine is set up in each case, which can be rolled together and the teeth of the larger relieved as much as necessary to make the action smooth. Then the points of both the gears should be further relieved to ease the approach of the teeth so that the bearing of the teeth will not be so hard at the points as near the pitch line. The amount taken off the templets can then be measured in some convenient way and the forming tools relieved a like amount. There are, of course, limits to the application of the preceding methods, but they are capable of use in the majority of cases when the gears to be made are of reasonably moderate size in relation to the size of the miller that is available. The width of the space in the forming tool made by the second method is not made equal to the thickness of the tooth, but may be considerably wider and the cutter tooth formed one side at a time. This is necessary in the cases where a side relief is given.

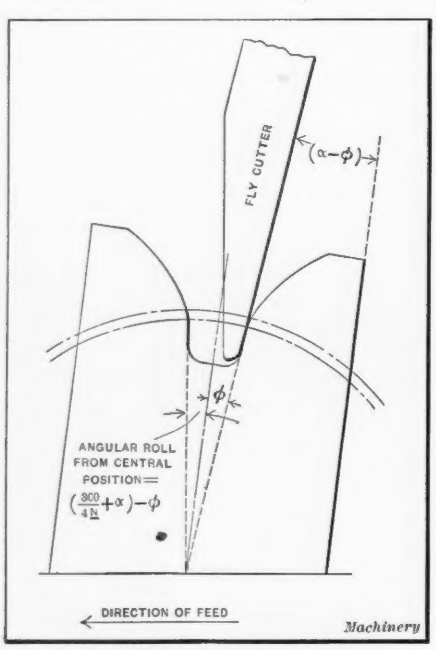


Fig. 7. Diagram showing Angular Relation between Fly Cutter and Forming Tool at Conclusion of Roll to give the Proper Radial Flank

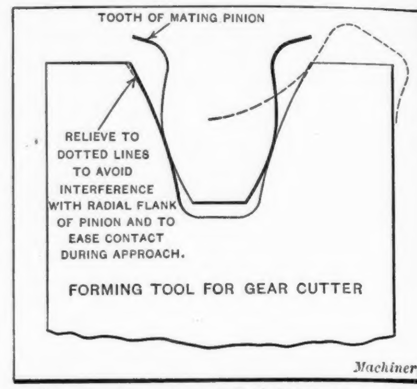


Fig. 8. Correction of Tool Setting to avoid Interference with Radial Flank of Pinions

These methods are especially valuable in those cases where it is desired to make cutters for any special number of teeth where the standard cutter is not satisfactory, as the methods in the hands of particular men are capable of producing a very high grade of forming tool and the second method is capable of extension so that when the fly cutter is replaced with a grinding wheel, the form of the tool can be ground after hardening to produce a tool free from the distortion due to hardening. This grinding also gives the tool a much keener cutting edge, resulting in a better job of forming in the cutter and a better finish on the gears.

* * *

Under the law governing the use of trademarks in Argentina, any person may register a trademark if such mark has not been previously registered in the country. This provision has permitted many unscrupulous persons to abuse the privilege by anticipating the advent into this market of a foreign trader or manufacturer. His trademark has been registered and he is then compelled to pay an exorbitant sum for the use of his own trademark. A provision has now gone into effect that a person who has registered a trademark cannot institute criminal proceedings for infringement, unless he himself manufactures or deals in the goods distinguished by the trademark in dispute. This has to some extent improved the conditions.

* * *

The permanent international committee for international aeronautics, 19 rue Blanche, Paris, has offered two prizes for competitions relating to aeronautic achievements. One of the competitions deals with the attaining of the greatest difference in speeds with the same aeroplane and the other with means for rising vertically, or nearly so, from a given point into the air, and for descending vertically. Further particulars may be obtained from the Commission Permanente Internationale d'Aéronautique, at the above address.

SCREW MACHINE TOOL EQUIPMENT*—1

STANDARD TYPE OF TOOLS USED ON THE CLEVELAND AUTOMATIC SCREW MACHINE

BY DOUGLAS T. HAMILTON†

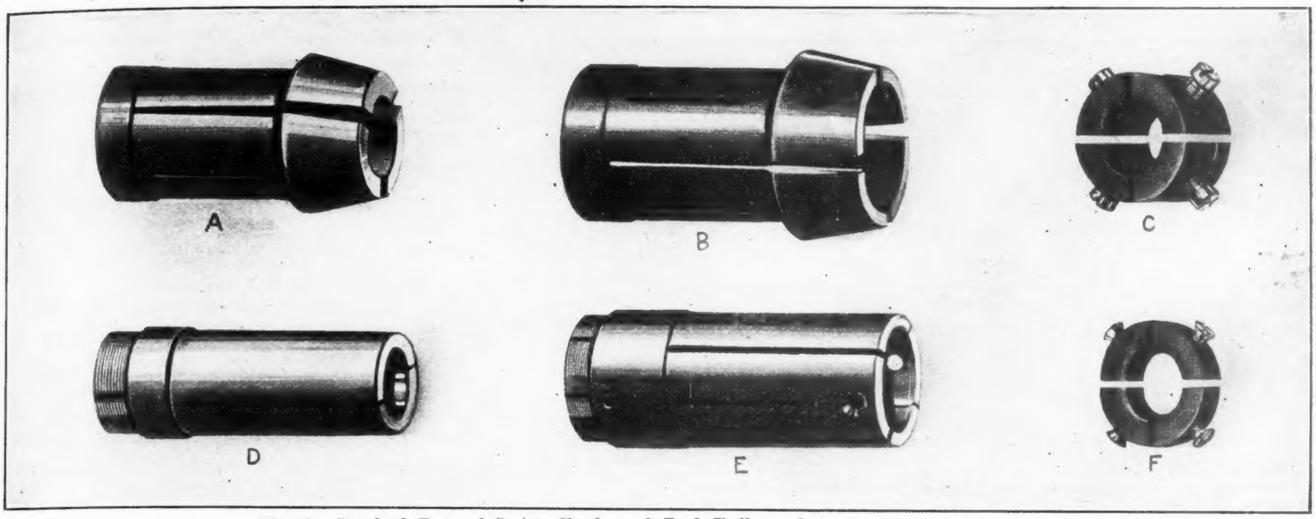
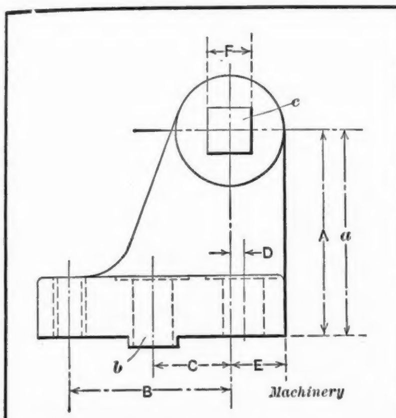


Fig. 1. Standard Type of Spring Chucks and Feed Shells used in the Cleveland Automatic

THE turret and cross-slide tools used on the Cleveland automatic screw machine differ only to a slight extent from those used on other screw machines, but of course there are a few tools particularly adapted to this type of automatic. As a general rule, forming tools of the flat type are are easily sharpened when dull, but the clearance on the sides, especially when diameters differing greatly in size are to be formed, is not nearly as good as on the flat type. Consequently this type of tool is used almost exclusively on Cleveland automatics.

PRINCIPAL DIMENSIONS OF SINGLE AND DOUBLE CROSS-SLIDES



Double Slides on Model "A" for these Sizes take the same Tool-posts as Models "B" and "C"

Size of Machine	Model "A" Machine A	a	B	C	D	E	F
3/8	1 3/8	1 1/4	1 5/8	1/2	.....	7/16	3/8
5/8	2 5/16	2 3/16	1 3/4	*	.....	5/8	1/2
7/8	2 7/16	2 5/16	2 1/16	1/4	.....	11/16	9/16
1 1/4	2 11/16	2 9/16	2 1/16	*	5/16	1 17/32	9/16
2	2 11/16	2 9/16	2 1/16	*	5/16	1 17/32	9/16

Size of Machine	Model "B" Machine A	a	B	C	E	F
3/8	1 3/8	1 1/4	1 5/8	1/2	7/16	3/8
5/8	2 5/16	2 3/16	1 3/4	1	5/8	1/2
7/8	.....	.....	.....	.....	.....	.....
1 1/4	2 11/16	2 9/16	2 1/16	1	11/16	9/16
2	2 11/16	2 9/16	2 1/16	1	11/16	9/16

Size of Machine	Model "C" Machine A	a	B	C	E	F
3/8	.....	.....	.....	.....	.....	.....
5/8	.....	.....	.....	.....	.....	.....
7/8	2 7/16	2 5/16	2 1/16	1	11/16	9/16
1 1/4	2 11/16	2 9/16	2 1/16	1	11/16	9/16
2	2 11/16	2 9/16	2 1/16	1	11/16	9/16

For Single or Double Cross-slides. (All Dimensions in Inches)

Size of Machine	Model "A" Machine A	a	B	C	D	E	F
2 1/4	2 7/8	2 5/8	2 1/16	11/16	.....	3/4	5/8
2 3/4	2 29/32	2 19/32	2 1/2	1 11/16	.....	1	5/8
3 1/4	2 29/32	2 19/32	2 1/2	1 11/16	.....	1	5/8

Size of Machine	Model "B" Machine A	a	B	C	E	F	Model "C" Machine A	a	B	C	E	F
2 1/4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2 3/4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3 1/4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Machinery

used on the Cleveland automatic screw machine, because of the better side clearances obtainable. Circular forming tools

* For additional information on screw machine practice see "The Cleveland Automatic Screw Machine," in the April and May, 1914, numbers.
† Associate Editor of MACHINERY.

Spring Chucks and Feed Shells

The spring chucks used in the Cleveland automatics are of the push type as shown in Fig. 1; those up to 1⅜ inch capacity are of the solid type as shown at *A*, and those larger

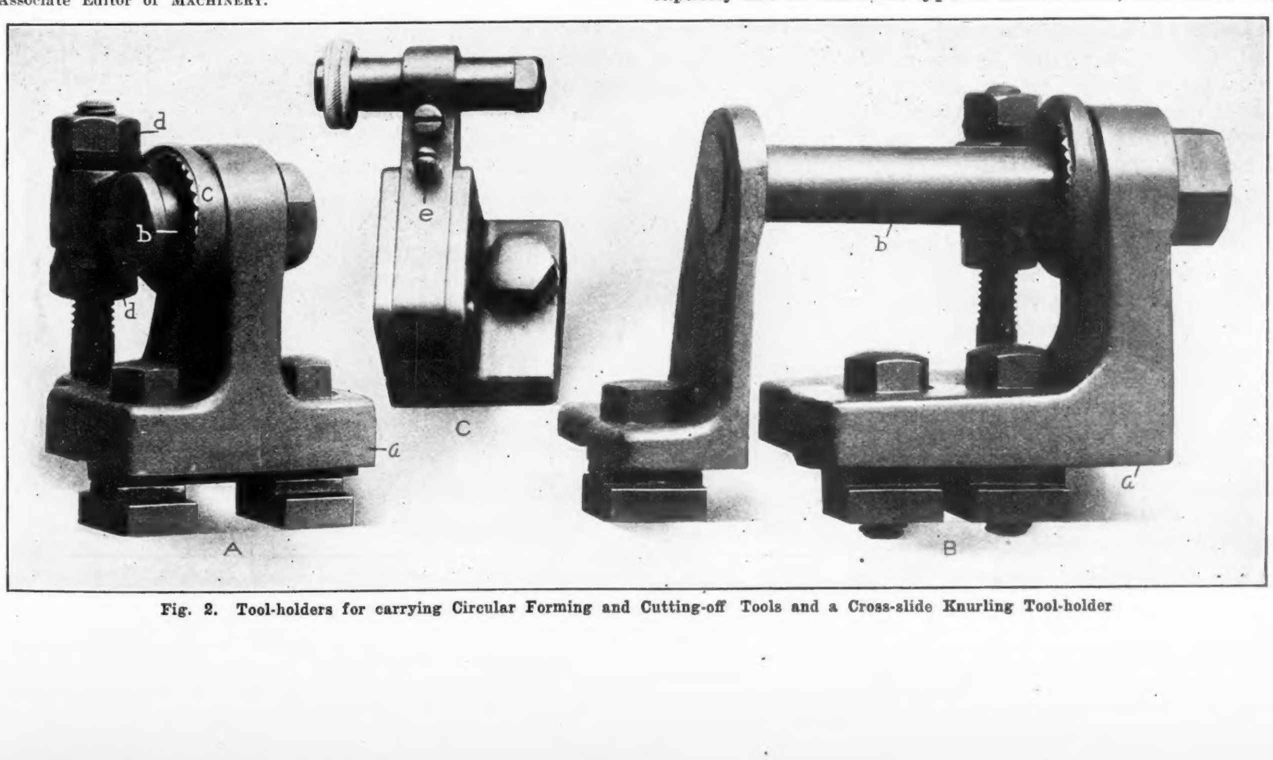


Fig. 2. Tool-holders for carrying Circular Forming and Cutting-off Tools and a Cross-slide Knurling Tool-holder

than this are of the type shown at *B*. The chuck at *B* carries pads which are held in the nose by screws, as shown, a pair of pads being illustrated at *C*. The feed shell used for pushing the stock through the chuck is of the spring type, as shown at *D* and *E* in Fig. 1, and on sizes up to 1⅜ inch capacity the solid type of feed shell as shown at *D* is used.

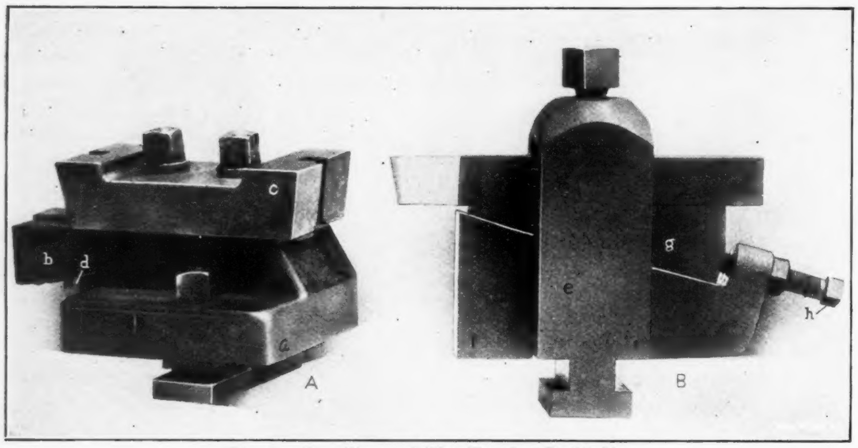


Fig. 3. Two Types of Flat Forming Tool-holders

For stock of larger diameter, the feed shell at *E* is used; this is provided with the pads shown at *F*, which are held by screws as illustrated. Both the spring chucks and feed shells, of course, are made to handle various shapes of stock; the chucks are ground 0.005 inch larger than the bar stock, and the feed shells are reamed 0.010 larger than the bar. This permits the chuck to get a better grip on the stock and hold it more securely while it is being operated upon. The hole in the chuck, of course, is made the same shape as the stock that it is intended to handle.

Toolpost for Circular Forming and Cut-off Tools

Two types of toolposts for holding circular forming and cut-off tools are illustrated in Fig. 2. *A* shows a toolpost known as the single type, which can be used for narrow forming tools or cut-off tools, whereas tool *B* is used principally for extra wide forming tools and is known as the double type. These toolposts are used either on the rear or front of the cross-slide, and they comprise a forging *a* which acts as a bracket for carrying the stud *b*. This stud fits in the hole in the tool and, as shown at *A*, is provided with a head which holds the tool up against the adjusting ratchet *c*. The outer face of this ratchet is provided with teeth which fit correspondingly shaped teeth in the inner face of the circular tool, holding the tool rigidly and at the same time making adjustment possible. This is secured by means of the adjusting nuts *d* which bear on cup-shaped washers fitting in similarly shaped holes in the extended arm of this adjusting member. Adjustment of the cutting edge of the tool is secured by moving these nuts up or down, as requirements demand. The forming toolpost shown at *B* is provided with an outer bracket which supports the extended bolt. This tool has three clamping bolts for securing it to the cross-slide of the machine. Adjustment for the circular tool is obtained in the same manner as for the type shown at *A*.

The accompanying table gives the dimensions for the circular forming type of toolposts for machines having capacities from ⅜ inch up to and including 3¼ inches. The 3¼-inch machine is about the largest size of Cleveland automatic on which the circular type of tool-holder is used. On sizes larger than this the flat type, which will be described later, is used almost exclusively. The upper portion of the table gives dimensions for toolposts which can be used on all three models A, B and C, having either single or double cross-slides; whereas the lower portion of the table gives toolpost dimensions applicable only to the model A machine. The spaces occupied by an asterisk indicate that the center of the tongue *b* is on the center line of the hole *c*. Hence, of course, dimension *C* is omitted.

Toolposts for Flat Forming Tools and Blade Cut-off Tools

The toolpost shown at *A* in Fig. 3 is the standard type of flat forming tool-holder that is used principally on machines having a capacity from ⅞ to 7¾ inches. This toolpost consists of a base *a*, the top face of which is beveled to an angle of about 15 degrees, which fits a beveled wedge *b*. The wedge *b* is provided with a tongue which fits into a corresponding groove in the top face of base *a*, and the top face of the wedge is provided with a groove that fits into a corresponding groove in the base of the flat forming tool *c*. Adjustment for height of the cutting edge of the forming tool is secured by means of a collar head screw *d*, which fits into a series of slots, depending on the height required, cut in the base of the wedge, and is screwed into the base *a*. The forming tool is held on the top face of the wedge by two clamping bolts as illustrated, and the entire toolpost is fastened to the cross-slide of the machine by bolts as shown.

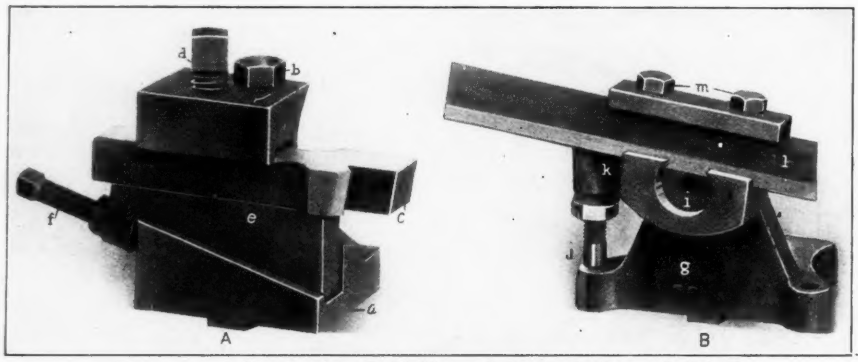


Fig. 4. Open-side Forming Tool-holder and Standard Universal Cut-off Tool-holder for Cut-off Tools of the Blade Type

B in Fig. 3 shows another type of toolpost used for light forming tools or for cut-off tools that are not of the blade type. This tool-holder is of simple construction as the illustration shows, and consists chiefly of three members, a clamping strap *e*, a base *f* and a tapered wedge *g*, the latter being adjustable to the desired height by a screw *h*. This holder, like those shown in Fig. 2, can be used on either the front or rear part of the cross-slide.

The tool-holder shown at *A* in Fig. 4 is known as an open-side forming toolpost for holding forming tools with square shanks. This toolpost comprises a block *a* which is fastened to the cross-slide by means of the bolt *b*, the lower end of which is screwed into a T-block. An additional clamping bolt in the base, not shown, is also used for clamping this

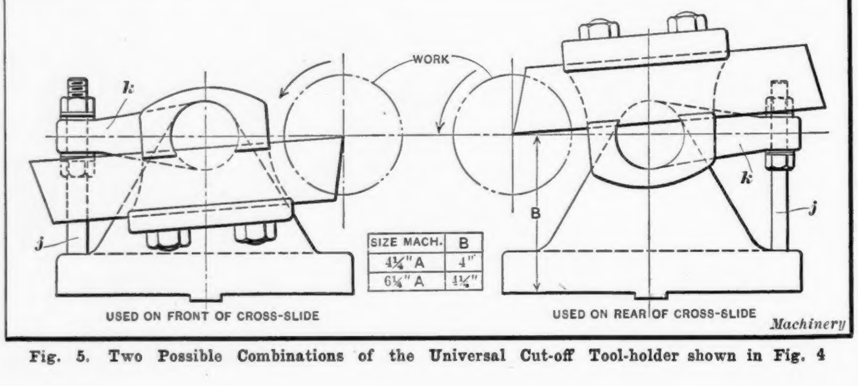


Fig. 5. Two Possible Combinations of the Universal Cut-off Tool-holder shown in Fig. 4

toolpost to the cross-slide. The forming tool *c* is held in the base by the set-screw *d* and is adjusted to the proper height from the cross-slide by the wedge *e*, the adjustment being secured by the screw *f*. The chief advantage of this type of toolpost is that a tool to be used in it can be made up very quickly and cheaply.

The toolpost shown at *B* in Fig. 4 is known as a universal cut-off toolholder, and is adaptable for use on either the front or rear of the cross-slide, as clearly shown in Fig. 5. Referring to Fig. 4, the post *g* is so arranged that it may be clamped to either the front or rear of the cross-slide. The swinging tool-holder *h* is pivoted on the bolt *i* which also clamps the holder, ratchet and post together. A threaded stud *j* supports the ratchet *k* and this ratchet gives the adjustment to the tool-holder *h*. The blade type of cut-off tool *l* is clamped in place by two bolts *m*.

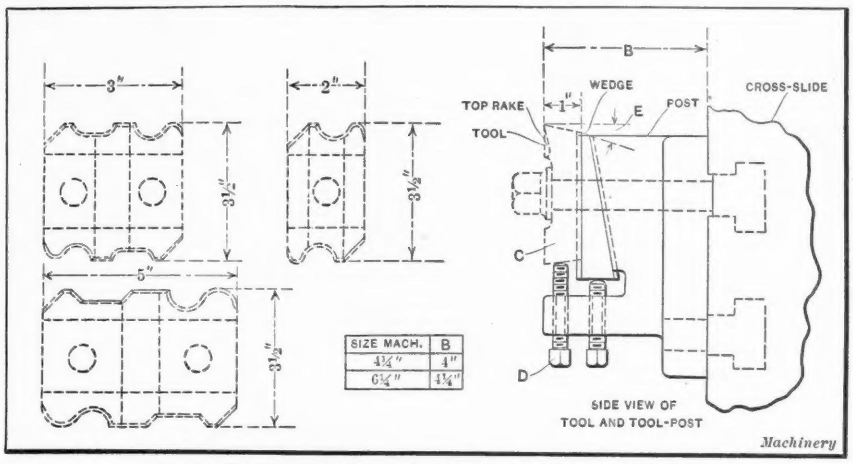


Fig. 6. Diagram illustrating Tool-holders for holding Large Flat Forming Tools and Proportions of Large Flat Forming Tools

This toolpost can be used in various combinations, two of which are shown in Fig. 5. As shown to the left of this illustration, the cut-off tool blade is reversed with the cutting edge up, and in this position can be used on the front part of the cross-slide with the stock rotating in the direction indicated. It can be used on the rear of the cross-slide, as shown to the right of the illustration, with the cutting edge down and the spindle running forward as indicated by the arrow. It can be used on the rear of the cross-slide by reversing the blade and holder, cutting edge up, with the spindle running backward. Again, it can be used on the front of the cross-slide by reversing the position of ratchet *k* and threaded stud *j*, leaving tool-holder *h* in the same position that it formerly had, with the cutting edge up for the spindle running forward. It can also be used on the front of the cross-slide by reversing the tool-holder and blade, cutting edge down, and spindle rotating backward. Fig. 5 also includes a table giving the distance from the base to the center of the spindle on the 4¼- and 6¼-inch machines.

Fig. 6 shows the type of flat forming toolpost used on the larger sizes of machines from 4¼ inches up. The flat forming tool *C* is backed up by a set-screw *D*. This screw is not used for adjusting purposes, but simply to prevent any backward thrust of the cutter owing to a slight difference in the size of the hole and the diameter of the clamping stud. It also increases the rigidity of the tool.

The same illustration gives diagrams of the different sizes and proportions in which flat forming tools are made. The width in all cases is the same, but the length varies, depending on the work on which the tool is to be used. The angle *E* on the flat forming tool varies from 5 to 15 degrees, depending upon the material it is intended to cut. The top face of the tool is left flat as a rule, but on cutting cold-rolled steel and soft iron it has been found advisable in some cases to cut out the top; this is indicated by the dotted line in the end view, as top rake. Care must be exercised in doing this when the tool contour is of irregular shape. The peripheral speeds recommended for forming and cutting off various materials with cutting tools made from high-speed steel are as follows:

Material	Surface Speed in Feet per Minute
Brass	180–220
Cold-rolled steel	70–125
Tool steel	40–50

Drill, Reamer and Centering Tool Holders

Four different types of drill-holders are shown in Fig. 7. Type *A* is an ordinary drill-holder and is of simple construction, comprising a shank, the front end of which is drilled out to suit the tool, which is clamped by a set-screw located in a ring as shown. This holder will only retain drills of the size that it has been made for. *B* is a floating reamer holder. The holder shown at *C* is somewhat similar to that at *A*, but in this case the centering drill is held in position directly by the set-screw instead of depending on the spring of the metal. The holder at *D* is of the chuck type. The nose is bored taper, and a cone-shaped collet fits in it, which, when drawn back by the nut, holds the drill in position. A combination drill and chamfering tool-holder is shown at *E* in Fig. 7. This tool-holder, as the illustration shows, comprises a shank *a*, split on the front end and carrying the drill. Surrounding the front end of the shank is a holder *b* in which a chamfering tool *c* is held by a set-screw as shown. Holder *b* is clamped to the shank of the tool by a set-screw which, in addition to retaining the holder *b* in position, also clamps the drill.

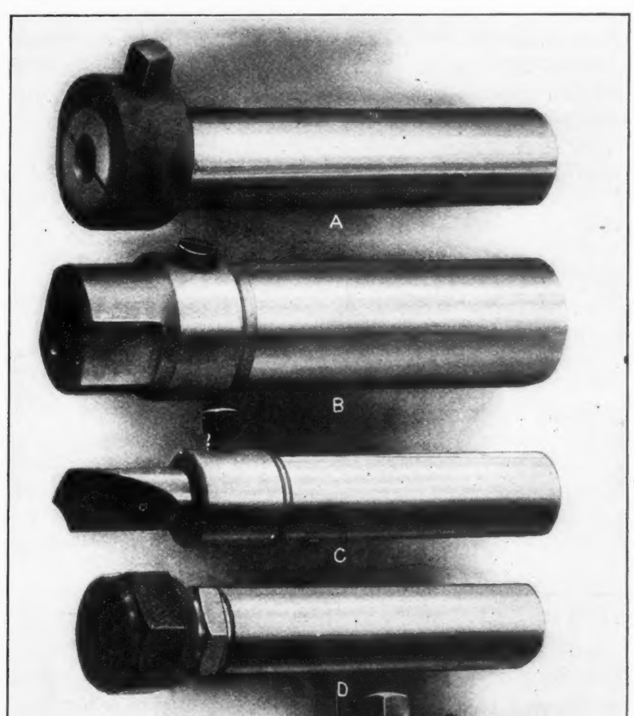


Fig. 7. Standard Drill, Reamer and Centering Tool-holders

The following gives the peripheral speeds recommended for drilling and counterboring operations when using tools made from high-speed steel:

DRILLING

Material	Surface Speed in Feet per Minute
Brass	180–250
Cold-rolled steel	90–100
Tool steel	40–50

COUNTERBORING

Material	Surface Speed in Feet per Minute
Brass	180–220
Cold-rolled steel	70–100
Tool steel	40–50

TUMBLER GEAR DESIGN*

BY S. C. B.

The accompanying illustrations will prove useful in calling attention to a number of points that are sometimes overlooked in tumbler gear design. In all the illustrations, the driving and driven gears are shown of the same diameter, and the force diagrams are drawn to the same scale. The force diagrams apply to involute teeth having a pressure angle of 20 degrees. The frictional losses in the bearings and between the teeth of the gears have been disregarded. In order to make the illustrations clear, only the pitch lines and base circles have been drawn. The outside circumferences of the gears have been omitted.

In Fig. 1, line *DE* represents to a given scale the force acting tangent to the pitch line of the driver, and *FE* is the resultant pressure normal to the tooth curve, and also the pressure on the bearings, *DF* being the component force acting to push the gears apart. The angle a is equal to 90 degrees minus the pressure angle of the gear teeth. Line *FE*, normal to the tooth curve, is tangent to the base circle and intersects the pitch lines on the line of centers.

Figs. 2 and 3 show the effect of changing the position of the tumbler gear with relation to the driving gear and also the effect of changing the direction of rotation of the driving gear with relation to the tumbler. Forces *EF* and reactions *GF* are determined as in Fig. 1. Completing the parallelogram of forces, we find *DF* to be the resultant force tending to move the tumbler gear. It should be noted that in each case *DF* passes through the center of the tumbler gear. The force *DF* multiplied by the perpendicular distance from *DF* (or *DF* extended) to the center *O* of the driving gear gives the turning moment acting on the tumbler arm *OH*. The great difference in the values of forces *DF* in Figs. 2 and 3 should be noted.

Fig. 4 shows a graphical method for obtaining the size and center of a tumbler gear in which there is no resultant force, due to the tooth pressure tending to rotate the tumbler arm *OH*. This diagram will also prove useful in designing idler gears carried on overhung studs, as it shows the theoretical size of an idler gear which would cause the resultant forces on the idler stud, due to the tooth pressures, to be reduced to a minimum. The center *H* is found at the intersection of the extensions of lines *KN* and *OR* which are drawn through the intersections of a common tangent to the base circles of the driving and driven gears with the pitch circles of the same gears. By construction, angle a equals 90 degrees minus the pressure angle, and the normal forces *FE* and *FG* oppose each other and have no resultant acting on the center *H* of the tumbler gear. There is, therefore, no tendency to rotate the tumbler arm *OH*.

It will generally be found that the theoretical tumbler gear thus determined will be too large, but the knowledge gained by an analysis of this kind will be a great help in arriving at a correct design. This article has been written with the hope of provoking further discussion upon this very interesting subject.

* For articles on tumbler gear design, previously published, see MACHINERY, December, 1907, "Tumbler Gear Design," and December, 1899, "Tumbler Gearing." See also MACHINERY'S Reference Book No. 14, "Details of Machine Tool Design," Chapter IV.

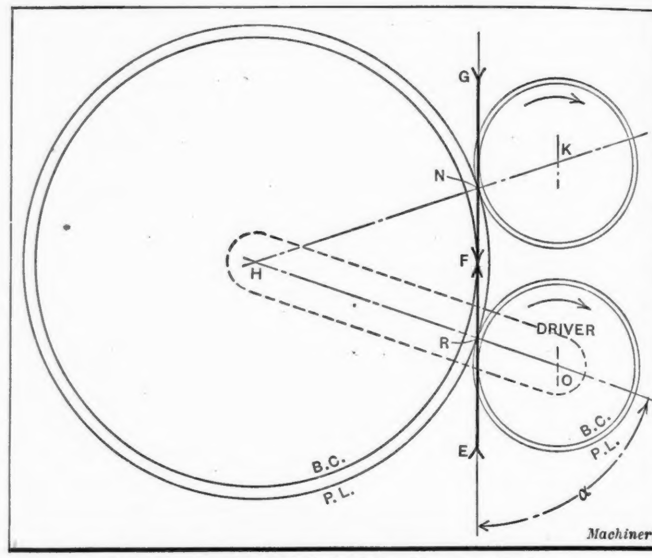


Fig. 4. Graphical Method of Tumbler Gear Design

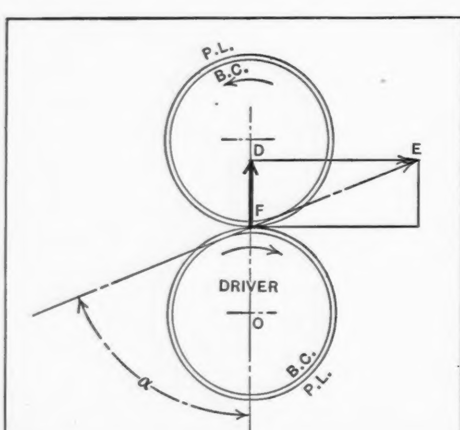
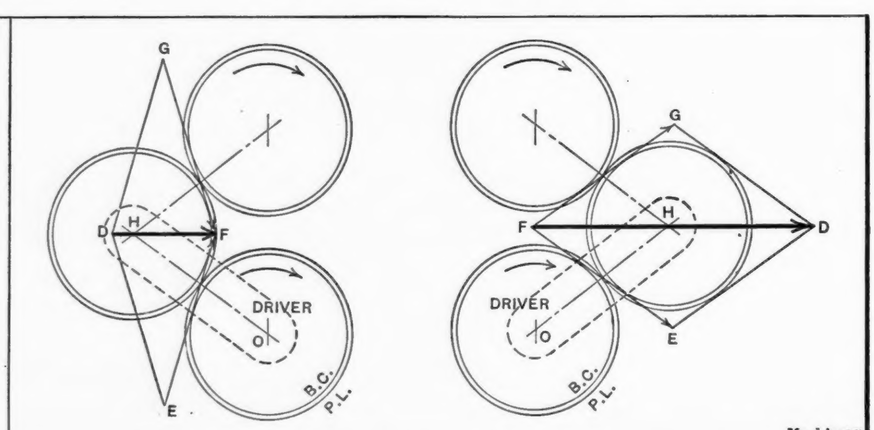


Fig. 1. Forces due to Tooth Pressure in Gearing



Figs. 2 and 3. Diagrams showing Effect of changing Position of Tumbler relative to Driving Gear

* * *

REMOVING PAINT AND ENAMEL FROM TIN

BY G. G.

It is sometimes required to remove paint or enamel from tin, iron or other metal surfaces. Under ordinary circumstances, this is a long and tedious job, especially if the surface under the enamel or paint is required to be left clean and bright. A method which I have used successfully to overcome this difficulty is described in the following. This consists of treating the surface from which the paint or enamel is to be removed with either metallic mercury or bi-chloride of mercury. If the pieces to be cleaned are small enough in size, they may be placed in a receptacle containing a sufficient amount of mercury (quick silver) and held under the surface for about fifteen minutes. It will then be found that the paint or enamel may be easily rubbed off with the finger or a rag. If the pieces are too large to be treated in this way, lay them down so that the surface to be cleaned is horizontal, with the enameled or painted side up. Then cover these surfaces with metallic mercury and leave them for about fifteen minutes. The paint or enamel can then be rubbed off as previously described, leaving a clean surface. A typical application of this method is in the case of tobacco boxes, from which the enamel can be readily removed. When treated in this way, such boxes make attractive holders for small drills, reamers and other tools. If metallic mercury is not obtainable, bi-chloride of mercury will be found to answer the purpose nearly as well. A solution of this chemical is made by dissolving as much of it as possible in water. If this alternative method is used, great care must be exercised as bi-chloride of mercury is a deadly poison.

FILING YOUR OWN PATENT

BY BELL CRANK

In the February number of MACHINERY an article of this title was presented by Mr. Ford W. Harris, that should be particularly interesting to men who are developing ideas which they intend to patent. I have secured patents on several of my inventions and this experience has convinced me that it would be a distinct advantage for an inventor to make application for a patent without the aid of an attorney. In two cases I had my attorney make searches to see whether my inventions had been anticipated by others. He was an experienced and reliable man who was well-known to me, and he reported that there appeared to be no other patents that would prevent mine being granted. Yet when the patent office reported on them, they had found patents which so limited my claims that both patents were of but little more value than the expense to which I was put in securing them.

In another case I was so confident of the novelty of my device that, although I remembered the failure of his previous search, I instructed this attorney to go ahead. Again he reported favorably, but it was found by the patent office that my invention had been anticipated and so I lost the $15 fee charged by the government in addition to a $35 attorney's fee. In two other instances I secured patents without having a previous search made. This experience was the means of teaching me quite a little about the method of procedure in securing patents, and has given me a high regard for the thoroughness of the searches conducted by the patent office. As a result, I would not spend money to have a search conducted by an attorney because no attorney has facilities for making a search equal to that of the patent office. Even if he had such facilities and made a thorough search, he would charge so much for doing it that his fee would probably be more than the cost of an application for a patent.

There are a lot of "no patent no fee" attorneys who profess to make a free search to determine the patentability of an invention. It is extremely doubtful, however, if any of them do so; and if they report an invention non-patentable, which they very seldom do, it is not the result of a search but because they happened to know that the invention has been anticipated. When in doubt, they take chances and depend upon their skill and experience to "wriggle" through some sort of a patent, whether it is of any value or not, and thus obtain a fee. It is practically certain that if all patent attorneys prosecuted only such inventions as they honestly believed to be of any real value, about one-half of those now engaged in the profession would have to go out of business. It must not be forgotten that the usual attorney's search—for which the customary fee is $5—covers only United States patents. But there may be, and often are foreign inventions which interfere with the granting of a patent in this country. In the case of one of my own inventions, there were two foreign patents which prevented my obtaining two of the most important claims.

I feel sure that it is well worth while for an inventor of limited means to take the time and trouble to learn how to make application for a patent without employing an attorney. For the first fee of $15, the patent office makes an examination of the patentability of an invention that is far more thorough than any independent practitioner could conduct for such a fee. Unless an invention is entirely new, there are sure to be several previous patents cited by the patent office, which must be carefully considered in reference to the claims that are made. If the inventor believes that he has a very valuable device and the other patents do not seem to interfere materially with his claims, I would advise him to employ a reliable patent attorney to complete the prosecution of the patent. If, on the other hand, the invention is one of minor value and he feels sure that he is competent to carry the prosecution of the patent through to a satisfactory conclusion, the attempt may be made. Then, if the inventor finds it too difficult to go on with, he may still employ an attorney to complete the work. The inventor will find this very interesting work, and work which will increase his knowledge of the procedure of the patent office.

It is a common thing to hear people criticize the work of the United States patent office, but after an inventor has seen the facility with which the employes of this office find patents that interfere with the granting of his own, he is sure to have greater respect for their work. Even if he finds that his application cannot be granted because of previous patents, the knowledge which he has gained of the developments which have been made along the line of his own invention is usually worth all or more than the $15 fee which he has paid.

I believe that Mr. Harris' advice in regard to how an applicant for a patent should draw up his claims is about as clear as it could be made for the benefit of the novice. In this connection, I should like to earnestly advise those who have anything to do with applying for a patent to treat the examiners who have charge of their cases with the utmost courtesy, and to endeavor to make friends of them. The rules of the patent office are strict in regard to this matter and even a registered attorney may be disbarred for misconduct in prosecuting applications. You may think that the examiner is very strict in regard to a technical matter which appears of minor importance to you; but it pays to concede to his wishes in such things, for he is certain to know more about it than you do. The essential elements of the claims may easily be retained and still allow you to make the changes which the examiner suggests, as there is always more than one way of saying the same thing. The salaries paid the examiners are not as high as those paid to men of equal ability who are employed outside the government service. Those who continue in the patent office do so because of their interest in the work, for which they certainly deserve due respect.

In regard to the sort of attorney to employ, a contributor in the April number of MACHINERY—himself a patent attorney —lays great stress on the need of employing a practitioner, even though he is incompetent. In this contribution, the statement is made that the office registration of patent attorneys is a very strict matter and that the requirements are severely enforced. This may be so, but no satisfactory proof was offered to substantiate it. The rules of the office, as published, state that any citizen of the United States who is not an attorney may be registered, if he can satisfy the commissioner that he is of good moral character and possesses legal and technical qualifications to make him competent to render valuable services to applicants for patents, and to assist them in making their applications. It is well known that there are a large number of patent attorneys who were examiners in the patent office, and never studied any law except that which was incident to their work as examiners. There is also very little doubt that any inventor who has successfully prosecuted a few of his own applications would have little difficulty in getting registered as an attorney.

In regard to what the contributor in the April number of MACHINERY says about the value of patents, *i. e.*, that someone can usually be found who is willing to pay the attorney's fee for an interest in the patent, it may be observed that although many attorneys advertise their willingness to secure a patent or waive their fee if they fail, and offer numerous inducements in order to secure clients, you never hear of any of them advertising that they will assume all expenses of securing a patent for a part interest in it. This is a startling evidence of how lightly they value the patents which they prosecute for their clients. I once heard an eminent inventor say that he would not give $5 each for all the patents that are issued, if he had to take all of them. This is equivalent to saying that not one patent in each hundred is worth $500. There is little doubt that every patent attorney of any considerable experience knows that the majority of patents issued never bring as much to the inventor as they cost him.

* * *

At the present time there is one motor vehicle to every fifty-five inhabitants in the New England states. During the past year, the number of vehicles registered in these states increased by nearly 25 per cent. About one-tenth of the total number of automobiles in the United States is registered in New England, while the population in these states is only about one-sixteenth that of the whole country.

SPECIAL BORING MACHINE USED ON WILLIAMSBURG BRIDGE

MACHINE THAT ENLARGED PIN-HOLES FROM TEN TO THIRTEEN INCHES IN ONE PASSAGE OF THE CUTTER-HEAD

IN the article on "Replacing Pins in the Williamsburg Bridge," in the June number of MACHINERY, mention was made of some of the problems connected with the strengthening of this bridge. As will be recalled by those who read this article, the work of reconstruction involved the replacement of the four hinge pins which connect the approach span trusses with those of the main span at points near the towers. The original pins were ten inches in diameter and it was necessary to rebore the holes to a diameter of thirteen inches for the new pins. In connection with this work a special boring machine had to be constructed, because of the unusual conditions which existed. A description of this machine and some interesting facts connected with its use are given in the following.

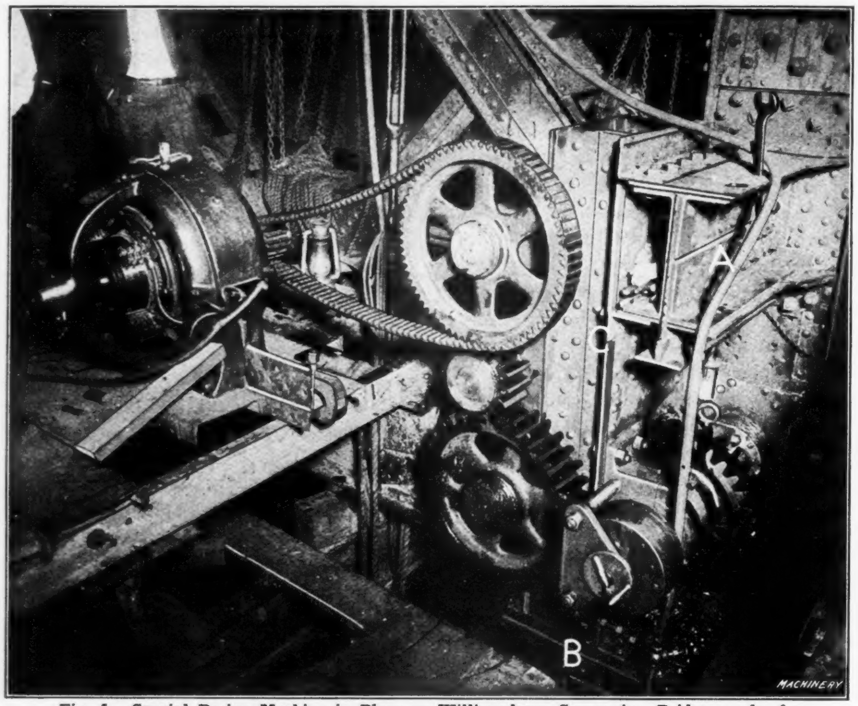


Fig. 1. Special Boring Machine in Place on Williamsburg Suspension Bridge ready for reboring Pin Hole from 10 to 13 Inches Diameter in One Passage of Cutter-head

As mentioned in the preceding article, the load carried by the old pins had to be transferred to a new girder erected transversely above the ends of the main span trusses close to the tower. In this way the pins were relieved of the dead load stresses, but part of the live and all of the "wind" loads were still transferred through these joints. Owing to this condition, it was impossible to rebore the holes while the railway and vehicular traffic continued across the bridge. As an interruption of this traffic during the day would cause great inconvenience, it was decided to do the boring at night, and nights of an even temperature and low wind were desirable, because, even under favorable conditions, it was considered hazardous to have a pin removed for more than two or three hours. Therefore, the time for the boring operation was limited, and even during this short time, the members held together by the pin were likely to move slightly and interfere seriously with the boring operation. Because of these conditions, it was apparent from the beginning that no ordinary boring-bar could be used, and it was decided to build a special boring machine; moreover, to prevent any relative movement of the members while boring, it was necessary to have them rigidly tied together. This was effected by an elaborate system of auxiliary members placed around the pin-hole. These were arranged so that they could be rigidly connected by bolts just before starting the boring operation, and be released as soon as the new pin was in place. The actual boring time was limited to a maximum of two hours, and a machine had to be designed to enlarge a hole thirteen inches for a distance of twenty-eight inches, in one passage of the cutter-head, and finish the hole to the required diameter within a limit of 1/64 inch.

In order to determine if a satisfactory hole could be obtained with roughing and finishing cutters working together, and to obtain the most efficient rate of feed, shape of tool, etc., a series of experiments were conducted in the shops of the Department of Bridges, and the data obtained were used in designing the machine. These preliminary tests showed that one of the most important points in the design was that of securing a rigid support, in order to avoid chattering. Among the special conditions that had to be considered were the ease of adjustment for centering the boring-bar as quickly as possible, the insertion and removal of the bar to permit placing the new pin in position, and the extremely limited space of only twenty inches between the center of the pin-hole and the side of the main tower. Furthermore, the machine had to be designed so that it

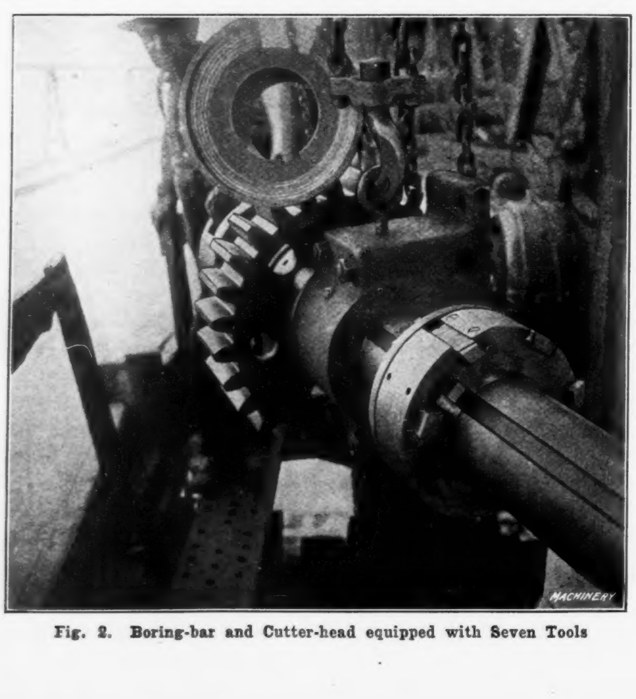


Fig. 2. Boring-bar and Cutter-head equipped with Seven Tools

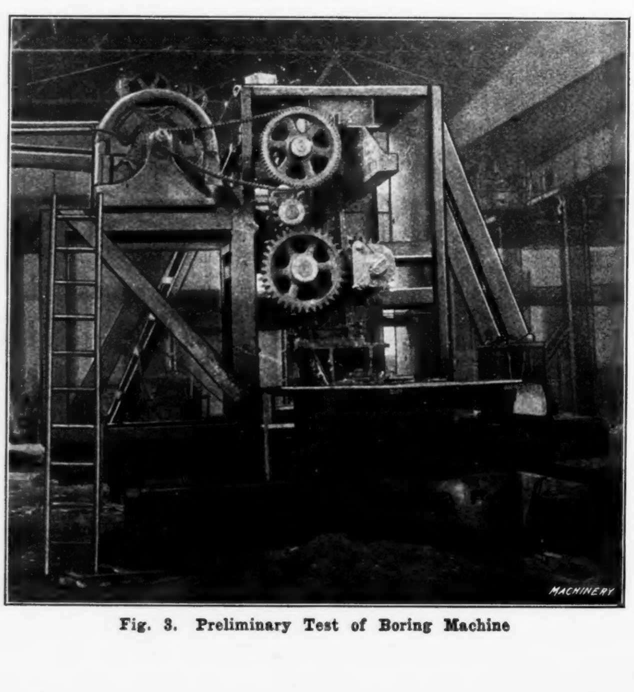


Fig. 3. Preliminary Test of Boring Machine

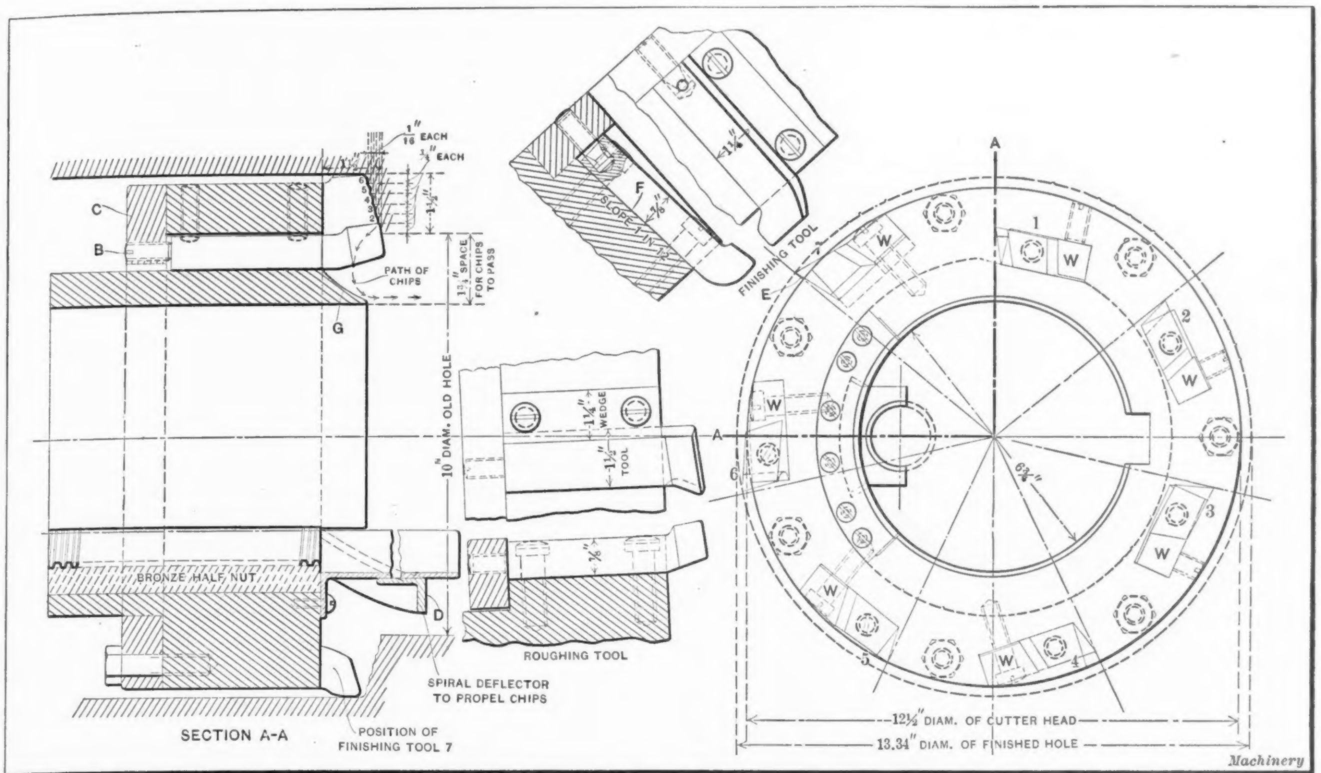


Fig. 4. Seven-tool Cutter-head used on Boring Machine

could be changed from right-hand to left-hand for boring the pin-holes on opposite sides of the tower. The most serious difficulty of all, however, proved to be the removal of the large quantity of chips without interference with the cutting tools, because in order to secure the necessary rigidity, the boring-bar was made 6¾ inches in diameter so that there was not much room between the bar and the ten-inch hole.

Owing to the importance and dangerous nature of this work, it would have been unwise to take any chances regarding the successful operation of the machine, and it was also imperative to know definitely the time required for the boring operation. To ascertain beforehand exactly what the machine would do a trial hole was bored, the conditions existing on the bridge being reproduced as nearly as possible. This preliminary test was made in the presence of representatives of the Department of Bridges at the shops of the Fawcus Machine Co. at Ford City, Pa., where the machine was built. Fig. 3 shows the machine assembled for testing. The post for this test was practically the same as the one on the bridge, and it was provided with members in the center arranged in the same slanting position that they occupied on the bridge members, so that the tools would work under corresponding conditions in each case. This test proved that the machine was entirely successful. The hole was enlarged from ten to thirteen inches in diameter in one hour four minutes, and a smooth surface obtained.

It was necessary to move the boring machine successively to four places on the bridge, but as the bridge construction in each place was similar, it was possible to utilize the framework of the bridge as a support for the machine. The connections of the roadway floor beams (the latter being detached to make room for the boring machine) were utilized for attaching the horizontal brackets *A* and *B* (Fig. 1). Bracket *A* held the upper end of the main post *C* of the machine, whereas bracket *B* supported the lower end. The open rivet holes of these connections located the supporting brackets in almost exactly the same position at all four points where the boring had to be done. The main post *C* rested on two taper adjusting blocks, which, in turn, were held by bracket *B*. These blocks gave both vertical and horizontal adjustment for post *C* and provision was also

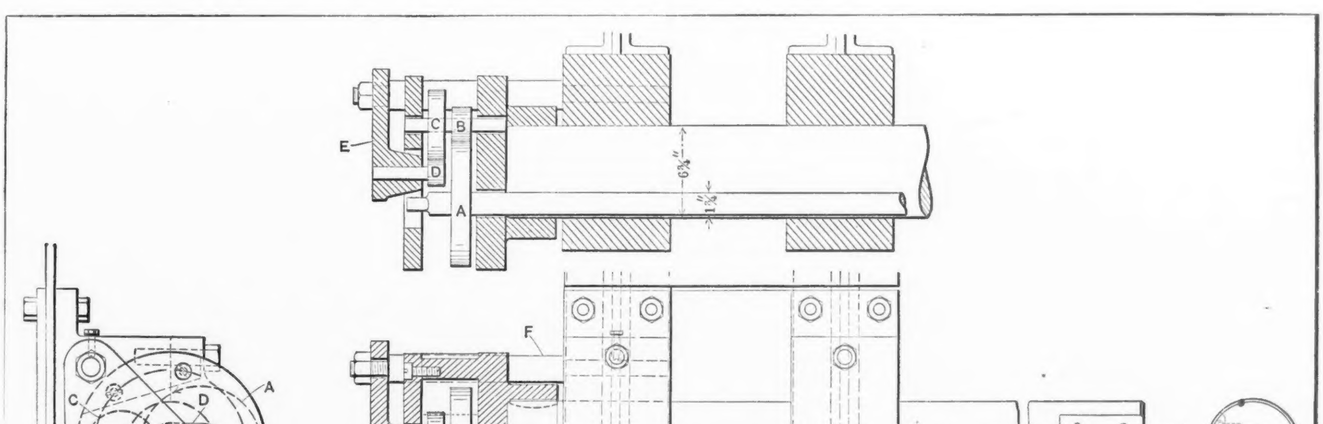


Fig. 5. Geared Feed Mechanism for Cutter-head

made for tilting this post transversely with relation to the bridge. The angle-plates connecting the post to bracket A were provided with slotted holes to permit of these adjustments. The post C consists of two built-up I-sections rigidly joined by plates. The driving gear on the bar (see Fig. 1) and its meshing gear enter between the two webs of this post. The power is transmitted from a 35-horsepower motor by a silent chain, and then through a train of gears giving a reduction of 49 to 1 from the motor to the bar. The journals for the gear shafts are attached to post C, which also carries the outer bearings of the bar. These outer bearings are bolted to finished surfaces on post C, so that the bar could readily be placed in position after the post was properly set. The rear end of the bar was supported by a journal clamped to the angles of the trolley track floor beams. This rear journal was so designed that it could be adjusted in all directions.

In order to center the journals of the bar, a piano wire was stretched through the small center hole of the old pin. The bearings for the bar, while attached to the main post

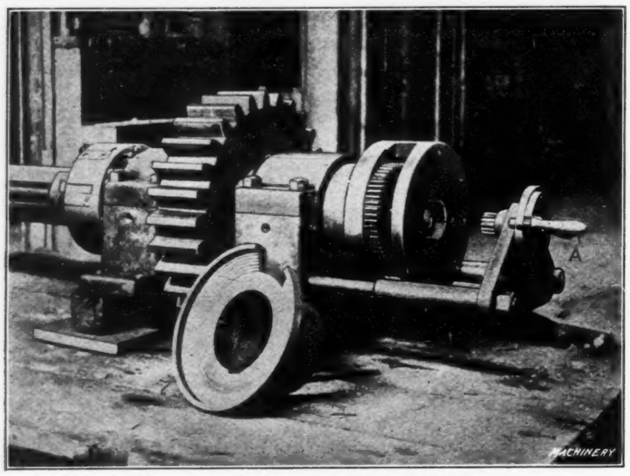


Fig. 6. Detail View of Feed Mechanism

of the machine, were then set central with this wire by adjusting the post, as required. The position of the bearings was checked by a gage consisting of a 1 7/16 inch bar which fitted the central hole of the old pin and carried three 6¾-inch removable collars which fitted the journals.

The cutter-head was fed along the bar by a feed-screw contained in a groove extending along one side of the bar. This feed-screw was operated by an epicyclic train of four gears, A, B, C, D (Fig. 5), located at the front end of the bar. These gears provided a reduction of 10 to 1, giving the cutter-head a feeding movement of 1/32 inch per revolution of the bar. The shaft of the central pinion D is journaled in the triangular plate E which is held by two studs F to the journal of the bar. To obtain an automatic feed, the pinion D was held stationary by the engagement of a pin in the handle shown at the right in Fig. 6, which engaged the plate shown. By withdrawing this pin, a hand feed of any desired rate could be obtained by turning the gear D in one direction or the other. For a quick return of the cutter-head, plate E was detached; then the feed-screw could be turned directly by a crank. The feed-screw was designed to be in tension during the boring operation, the axial thrust being taken by a stepped or collar bearing G (Fig. 5).

The forged steel cutter-head shown in Figs. 2 and 4 is 12½ inches outside diameter and six inches long. This cutter-head has seven cutters or tools, six being for roughing and one for finishing. Each of the roughing tools took a cut having a radial width of ¼ inch, the feed being 1/32 inch per revolution, as previously stated. The front edge of the inner cutter protrudes 1½ inch from the cutter-head, and the other tools are arranged in steps varying by 1/16 inch increments, toward the cutter-head, as shown in Fig. 4. The cuts were distributed between the different tools so that if one should break the following cutter could do the work of two tools. When boring one of the holes a tool did break, but this was not detected until the hole was successfully finished. The cutting speed for roughing was 45 feet per minute, and the speed for finishing was 51 feet per minute.

The four outer cutters are held in rectangular grooves cut across the edge of the cutter-head, whereas the three inner cutters are inserted into slots cut through the head. The roughing cutters are ⅞ by 1½ inch and are made of "Ultra Capital" high-speed steel. The rear edges of the tools are beveled and they are held by wedges W, which are forced downward by screws as shown. This method of holding the tools proved very effective. The position of all the tools can be adjusted longitudinally by means of set-screws B located in the back plate C. The finishing tool E rests in a seat F beveled axially so that the tool is not only adjustable in a longitudinal direction, but outward or radially to a limited extent. In this way, it was possible to regulate the diameter of the hole with considerable accuracy. The circular gage for setting the tools may be seen in the upper part of Fig. 2. It has a series of annular steps which represent the respective diameters to which the cutters must be set. The gage is partly cut away on one side and when it is placed on the bar, the steps or edges formed by this opening provide a simple but accurate means of setting the tools.

The removal of the chips presented a rather serious problem, as they had to pass forward through the long opening between the 6¾-inch bar and the wall of the ten-inch pin-hole. No chips could pass between the cutter-head and the thirteen-inch hole owing to the lack of room. This problem was solved by grinding the tools so as to produce chips in long curls not over 1½ inch in diameter, so that they could readily pass through the opening. As will be seen by referring to Fig. 4, the cutting edges incline backward in such a way as to curl the chips downward and cause them to follow the path indicated by the arrows. As the chips left the tool they were turned toward the front by the large fillet-like projection G on the cutter-head. To protect the feed-screw from the chips, a cover plate six inches long is attached to the front face of the cutter-head. On the face of this plate there is a spiral deflector D forming an angle of 45 degrees with the bar for propelling the chips forward. While boring the hole, the tools were cooled by a liberal supply of soap- and soda-water solution. Four barrels of this solution were placed on the top chord of the truss forty feet above the pin-hole, and the lubricant was directed onto the tools by the hose shown in Fig. 1.

All four of the pin-holes were bored without the slightest mishap. When boring the last hole, the old pin was removed at 10:30 P. M. and before midnight the boring-bar was ready for use. The traffic on the bridge was stopped at 12:15 A. M. Tying the members to be bored rigidly together, required fifteen minutes and the boring operation began at 12:30 A. M. The hole was enlarged to 13 inches by 1:30 A. M. While the machine was capable of finishing the hole in one cut, as originally planned, it was decided to take a 1/64-inch finishing cut in all cases, as there was time for a second cut. The latter required only forty-five minutes, as the motor ran faster under the light load. The new pin was in the hole and two new wind-chord members placed on it at 3:30 A. M. when the bridge was again ready for traffic after an interruption of only three hours fifteen minutes. That this work was done without a hitch was due to the careful planning of the Department of Bridges (F. J. H. Kracke, commissioner) and to the efficient design of the boring machine.

The power required to drive the boring-bar was calculated from the rules given by Taylor and Nicholson. The rule given by the former to allow as much power for feeding the tools forward as for turning the bar was adhered to. The ammeter and voltmeter readings taken at one minute intervals during the boring operation showed that nearly five horsepower was required for driving the machine when running without load, whereas the maximum power while boring was twenty-six horsepower. The calculated power was eighteen horsepower, but in this calculation no allowance was made for the friction caused by the chips in the hole, which proved to be quite high, as one horsepower less was required while boring the rear part of the hole from which the removal of chips could be assisted by hand. The weight of the boring machine frame is about two tons and that of the boring-bar, with the two main bearings attached, about 1400 pounds.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

DRAWING A CIRCULAR BRASS CUP

The following outlines the experience which the writer had in drawing a brass cup made from stock 1/16 inch in thickness. The first operation was performed in a combination blanking and drawing die of the usual type, and resulted in the production of a cup of the form shown by dotted lines *A* in Fig. 1. With the work carried to this point, it was desired to complete the cup in two operations, and the first attempt in this direction was made with the punches and die shown in Fig. 1. These tools were used in the following manner: A blank was placed in the die and the punch for the second operation was intended to force it down into the die, turning up the flange about point *E* and bringing the cup to the form shown in cross-section in Fig. 1. The punch for performing the third operation was similar to that used for the second operation, with the exception that the working rim was 1/16 inch longer. The purpose of this punch was to upset the lower edge of the rim. The trouble with this process occurred in the second operation. After the flange of the cup had been turned up about half way, the work offered so much resistance to being compressed that the metal began to turn up from the body of the cup at the point *D*, and this made it impossible to force the stock down into the die.

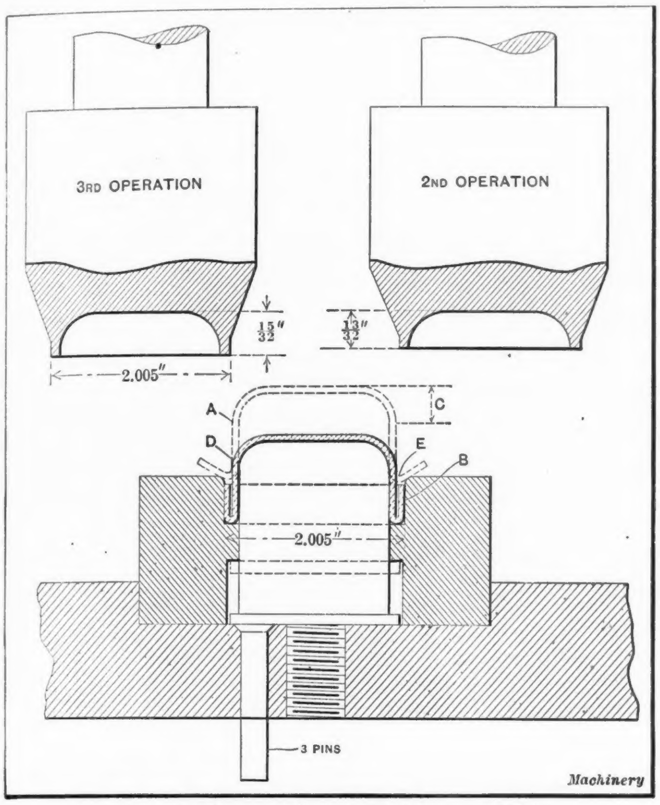


Fig. 1. Punches and Die that proved Unsuccessful for the Drawing Operation

To overcome this difficulty, the dies shown in Figs. 2 and 3 were designed. Fig. 2 shows the punch and die for performing the second operation, where it will be seen that the rim of the punch is extended in order to support the body of the cup at all points. The work is also supported from the inside by the spring plunger. When drawing the cup in this punch and die, deformation of the work is practically impossible. The design of the die provides for stripping the finished cup and also allows a free movement of the plunger, which is required to rise considerably above the die to facilitate locating the blank. The third operation is performed by the punch and die shown in Fig. 3, and the method of using these tools will be self-evident to any mechanic without a lengthy description. A blank upon which the second operation has been performed is inverted and forced down into the die. Great pressure is required to be exerted on the metal at *H* in order to upset it properly and produce a smooth surface. It was found necessary to taper the punch about 0.010 inch along the straight portion *J* in order to make it fairly easy to strip the cup from the die.

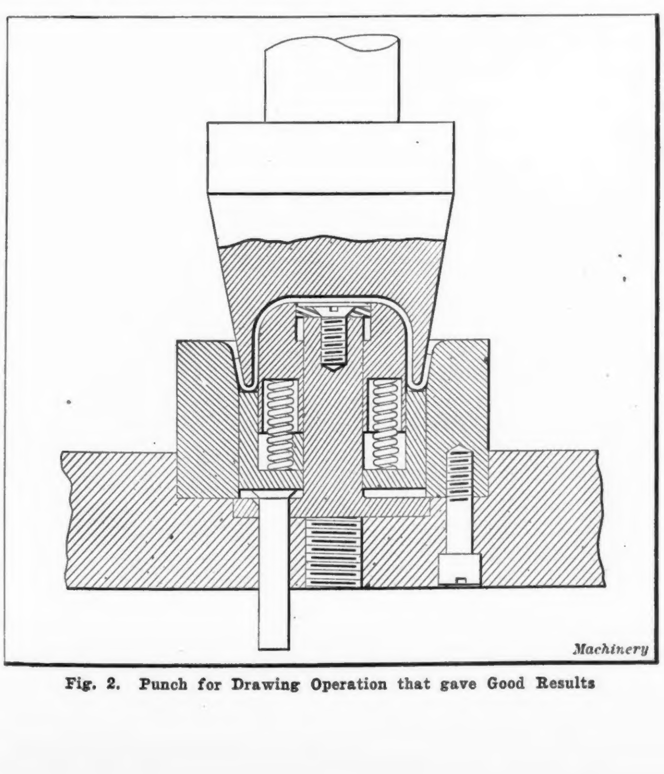


Fig. 2. Punch for Drawing Operation that gave Good Results

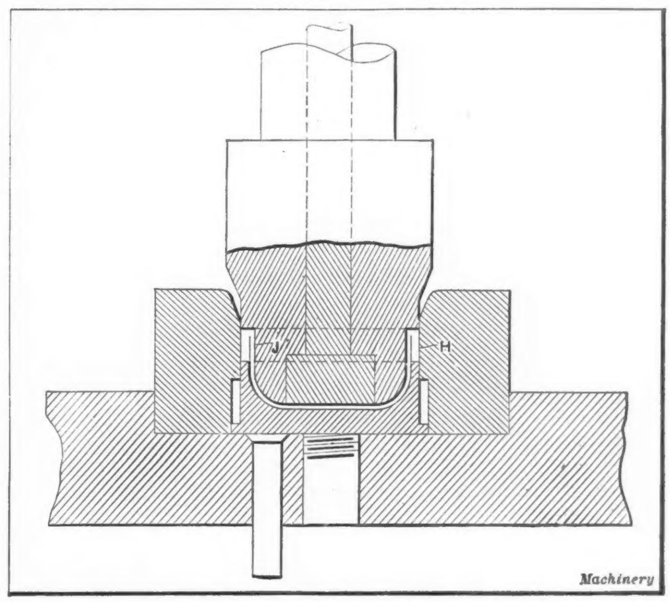


Fig. 3. Punch for upsetting the Edge of the Rim

Columbus, Ohio. OTTO R. WINTER

SETTING THE MILLING MACHINE TABLE AND KNEE

The method I am about to describe provides for locating a milling machine table and measuring the distance from the table to the center of the spindle, when it is desired to locate the table at a specified distance below the spindle. This method is rapid and accurate, and should be appreciated by milling machine operators who do a variety of work and are often required to bore or drill a hole at a certain distance from a finished face on the work, as in the case of a bearing bracket. The method of locating the table in a certain longitudinal position is also explained, this method being useful in cases where it is desired to locate the dividing head crosswise on the table and have it exactly opposite the spindle.

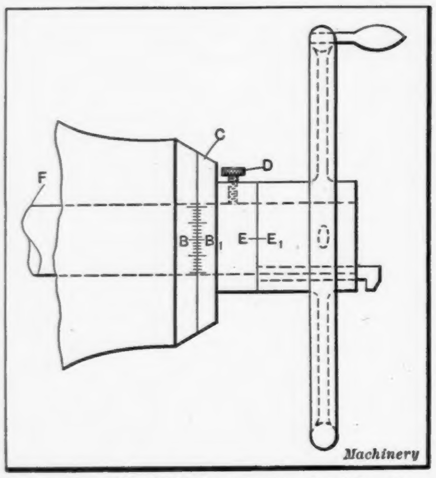


Fig. 1. Locating Height of Milling Machine Knee

Fig. 1 shows the knee handwheel, and a pair of angle plates for making the preliminary setting of the table relative to the spindle as shown in Fig. 2. The distance A is made any convenient length, and by the use of an indicator held in the spindle chuck the knee may be adjusted vertically until the spindle is centered on A. With this setting the table will be $\frac{A}{2}$ below the center of the spindle. Having proceeded thus far, a line is scribed on the column slide and knee, which serves as an approximate location. The zero line B_1 of the graduated dial C is next brought into coincidence with the zero line B on the boss of the knee, after which the dial C is locked to the feed-screw by means of the binding screw D. On the hub of the dial and the hub of the handwheel scribe zero lines E and E_1.

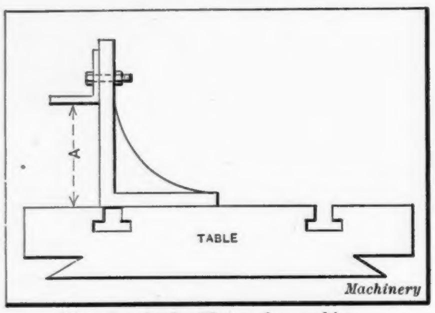


Fig. 2. Angle Plates for making Preliminary Setting

After the setting has been made in this way, the table may be returned to the starting point by first locking the dial C to the feed-screw F with the index lines E and E_1 in coincidence; then raise or lower the knee until the lines on the column slide and knee, and the index lines B and B_1 are both in coincidence. This shows that the table has been returned to the required point and the accuracy of the setting may be depended upon. Care should be taken that the tension of the screw is upward and that all of the table and knee locking screws are tight before the lines are scribed and the final adjustment is made. By locating the dial C with the index lines E and E_1 in coincidence, any location may be obtained by measuring with a scale from the line on the column slide and having the index lines B and B_1 correspond with the scale measurement.

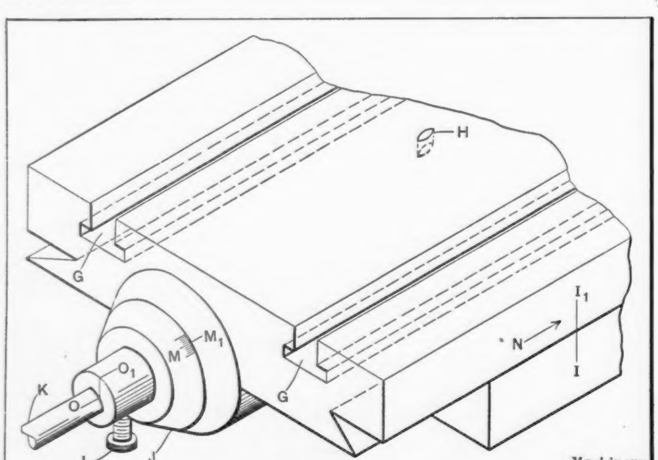


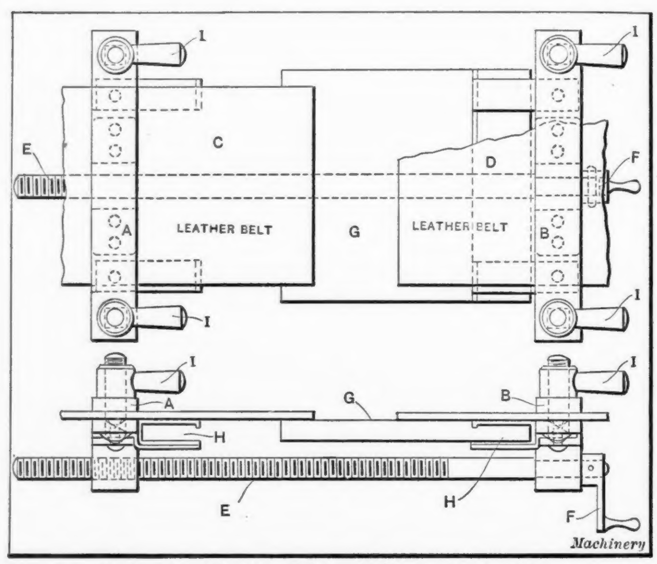
Fig. 3. Locating Longitudinal Position of the Milling Machine Table

Most of the milling machines used in jobbing shops are provided with an auxiliary baseplate or jig for use in setting the dividing head crosswise on the table, so that it is in line with the spindle. The method of making this setting is illustrated in Fig. 3. The jig is first located on the table by tongues which fit in the slots G and a dowel-pin H. With the dividing head in place on the jig, use an indicator in the chuck of the machine spindle to set the dividing head spindle in line with the machine spindle. When this setting has been made, scribe the index lines I and I_1 on the slide and table. Next lock the graduated dial J to the table feed-screw K by means of the binding screw L, having the zero lines M and M_1 in coincidence. Care should be observed to have the tension of the table feed-screw in the direction indicated by the arrow N when the lines are scribed and the final adjustment is made, and the same precaution should be observed in resetting. The reading of the handwheel and the distance of the table below center should also be observed and a memorandum of these readings should be preserved. To relocate the table in this position, the first step is to lock the graduated dial J to the table feed-screw K, having the index lines O and O_1 in coincidence. Then feed the table in the direction of the arrow N until the index lines I and I_1, and also the lines M and M_1 correspond. Using this method and having the jig located by the dowel-pin H, an accurate setting is assured.

Denver, Col. STANLEY EDWARDS

DEVICE FOR ADJUSTING DRIVING BELTS

The accompanying illustration shows a very simple and convenient device for stretching belting preparatory to cutting and lacing. It is similar in design to the various devices of its kind on the market today, but is particularly easy to manipulate. In the past I have been using the Gardner & Miller patent belt clamp, which is operated by two feed-screws with turnbuckles. This necessitates the use of both hands in tightening. It is also minus the cutting-board arrangement, which has to be supported by hand while cutting; I therefore "hit upon" the accompanying design.



Device for adjusting Driving Belts, equipped with a Cutting Board

The clamps A and B are operated by handle-nuts I, which work up and down on bolts with square shoulders, thus fastening the ends of belts C and D. The belts are then ready to stretch by means of the screw E which has a crank F on its squared end. The crank F is replaced by a wheel with a corrugated rim, which is used in preference to the regular crank when adjusting small belts, as it does not get too much tension on the belts and leaves them in condition for a future adjustment. The cutting-board G is then inserted in compartment H, leaving the belt ready for cutting and lacing.

Bronx, N. Y. ERNEST SCHWARTZ

A USEFUL T-SQUARE

While visiting a drafting-room recently my attention was attracted by a T-square that was being used by one of the draftsmen. From various catalogues, etc., in which the desired data could be found there had been clipped tables of decimal equivalents, bolt-head and nut sizes, pitch of stand-

ard screw-threads, number and letter sizes of twist drills and many other tables of use to the draftsman. These tables had been arranged and pasted on the top sides of the T-square blades, after which they were given a coat of shellac. It impressed me that the usefulness and convenience of this system could be applied generally, as it is not necessary to even look away from the board to obtain data that is in common use. It is surprising to know how much printed matter can be placed on the blade of an ordinary T-square.

Denver, Col. STANLEY EDWARDS

OIL VAPOR IN COMPRESSED AIR

I notice an inquiry by the O. B. M. Co. in the May number of MACHINERY on how to remove oil vapor from compressed air. As I have had to do with the lubrication of a great many air compressors in the work in which I am engaged, I would say that very often more oil is used in the cylinders of compressors than is necessary. The compressed air is dry and there is no moisture to wash the oil off the surfaces as in the case of oil cylinders, and but very little oil is needed to afford good lubrication. The company probably is using more oil than is necessary and it is the vapor which arises from the large amount of oil in contact with the hot surfaces that is causing the trouble. A smaller amount, just enough to give good lubrication, would not give off an appreciable vapor. The oil used should be sufficiently high in flash point so that it will not give off an appreciable amount of vapor at the temperatures ordinarily obtained in air compressors.

Two years ago while reorganizing the lubricating practice of a large corporation, I found at one plant, where several air compressors were in use, that the chief engineer used no oil whatever in his air cylinders but used soapsuds as a lubricant. The suds were made by dissolving a bar of hard soap in about five gallons of water, and were fed into the cylinder the same as oil.

Boston, Mass. WILLIAM N. DAVIS

EXAMPLES OF BELT GUARDS

The accompanying illustrations show three examples of types of belt guards which have been adopted for use in the plant of the Norwich Pharmacal Co., Norwich, N. Y. This firm has devoted a great deal of time and money to the provision of safeguards and after a thorough investigation has found that this type of belt guard gives very satisfactory results. Referring to the illustrations it will be seen that Fig. 1 shows the guard used to cover the belts of a drill press, while Figs. 2 and 3 show the application of this type of guard on woodworking machines. Guards are particularly important on woodworking machinery owing to the high speeds at which such belts are customarily run. The construction will be evident from the illustrations.

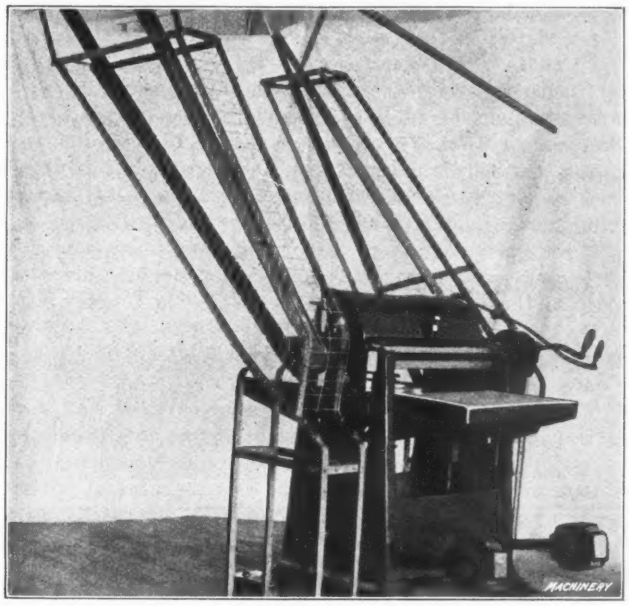


Fig. 3. Belts of a Wood Planer that are adequately guarded

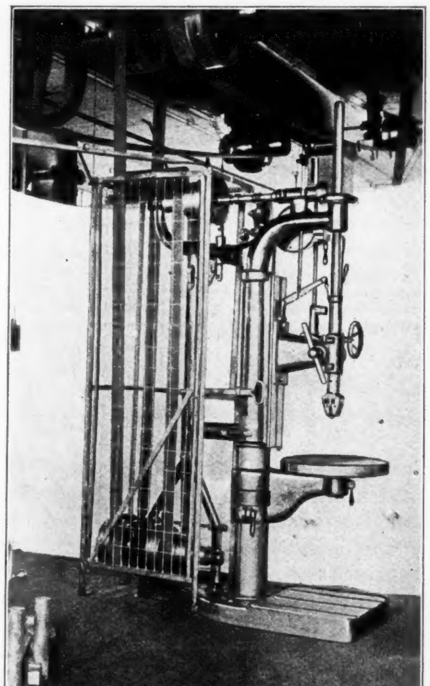


Fig. 1. A Simple Guard for Drill Press Belts

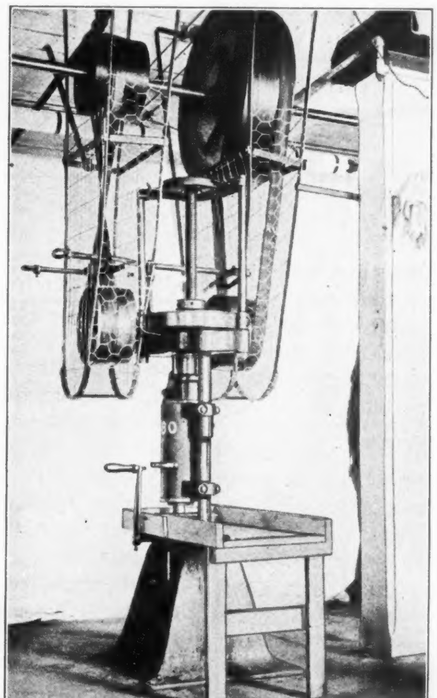


Fig. 2. Another Example of Simple but Efficient Belt Guards

Norwich, N. Y. GEORGE F. STACK

ETHICS OF CONTRIBUTING TO THE TECHNICAL PRESS

Much has been written on the question of the general rights of progressive men in regard to publishing descriptions of up-to-date methods, knowledge of which they have gained in their general experience, and it is easy to see that the matter cannot be arranged satisfactorily to all. The manufacturer generally thinks he is being wronged if one of his employes, or former employes, makes public some of his general methods of manufacture. On the other hand, the employe must be allowed some rights in the matter.

Many a man may have ability and qualifications which his present employer does not recognize or appreciate, but the man often is possessed with a determination to be recognized and sits down and thinks over different ways of doing it. He desires to prove that he can do what he claims he can. What better way is there to do this than to write of what he knows for the technical journals pertaining to his particular line of business? In his experience as a workman he has seen and studied the various methods used by him and—if he has the ability to hold a position requiring brains—has either made or suggested improvements and money saving features in connection with such methods that may, or, as is often the case, may not have been accepted by the powers higher up.

So, in the desire to help others willing to study and at the same time help himself, he writes for the magazines describing his experiences and methods he has improved upon. They are published, the general trade is benefited, he gets a check which will help him in his battle for a fair living, and nobody is a loser by such publication. Of course, it will be understood that the stealing of a valuable drawing and the furnishing of the same to the

press or to a competitor is not morally right or legal, but if a man sees a machine and is then clever and competent enough to make a good drawing of it and its motions and write about it on his own time, there can be no reasonable objection sustained by anybody.

As a matter of fact, when a firm refuses to raise a man's wages above a living rate, and lets him go out of its employ, there certainly can be no claim on him or what he has learned while with this firm. If there is anything that this firm does not wish anybody else to use, and it is really an invention, the only legal protection is a patent or copyright. If such a method is not novel enough to be granted such protection there should be no objection to the publication of it. As a matter of fact there is nothing done today that could not be improved upon, and these same manufacturers who object to the publication of some insignificant improvement which may have been used by their own former employers years back will welcome the publication of an improvement if made at the works of their competitors.

Publication of a method causes no actual loss. As a general policy, any manufacturer reading of an improvement on a method that is better than his own, immediately sets to work to make a still better one and the general public is thereby benefited. Any suppression of information for the purpose of enabling a few men to make their money more easily is a menace to our national progress and should not be considered. Were it not for the books and magazines published at the present time, our national mechanical development—the highest of any country—would be seriously crippled.

Southbridge, Mass. WARREN E. THOMPSON

THE MAKING OF RACE CAMS

Some time ago the problem of cutting a race cam similar to the one shown in Fig. 1 arose. This cam had to be cut on short notice and at low cost. The standard method of doing such work required a large amount of time and money to be spent in making a master cam for the cam cutting machine. The difficulty was easily and economically overcome by making the cam as shown in Fig. 2.

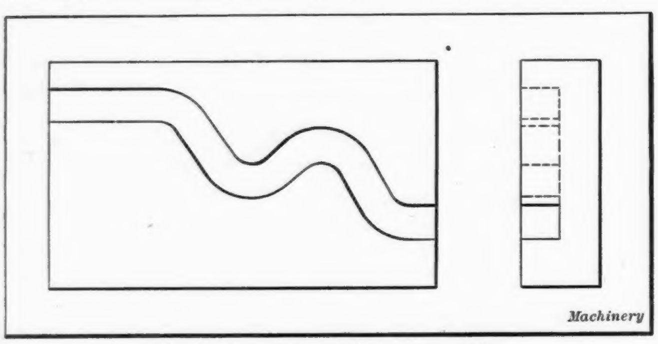


Fig. 1. Type of Race Cam to be made

Instead of using one casting, as is the usual practice, two castings were used. These were first machined so that the casting *A* in Fig. 2 had a thickness equal to the required depth of the raceway; and the other casting *B* was of such a thickness that when the two were fastened together they would have a combined thickness equal to that required for the cam. The piece *A* was cut with a surface on its upper edge which gave the outline of the lower side of the raceway. The other piece was then cut with a surface on its upper edge which corresponded to the upper side of the raceway. These two pieces were fastened together with countersunk machine screws and dowel pins, so that the two surfaces corresponded to the required surfaces of the raceway.

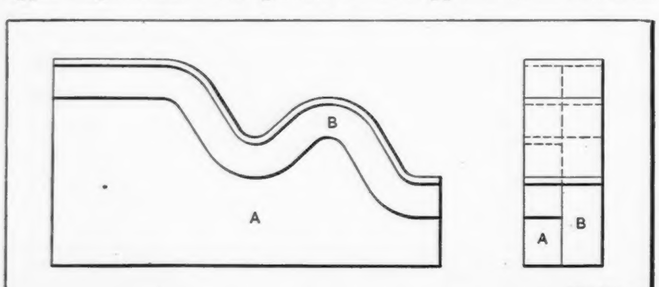


Fig. 2. How the Cam was finally made

A piece of sheet brass, 1/16 inch thick, and of a width equal to the thickness of the cam, was then bent so that it fitted perfectly with the surface of the upper side of the raceway. This piece was then fastened to the cam with countersunk machine screws. The result was a cheaper cam than could possibly have been produced by the old method, and an equally efficient one for the purpose for which it was required.

Philadelphia, Pa. SIDNEY K. EASTWOOD

DRILLING EQUI-DISTANT HOLES IN A STRAIGHT LINE

The method described in the following was used for drilling eighteen holes with a No. 48 drill through a piece of brass $\frac{7}{8}$ by $\frac{1}{8}$ by 24 inches in size. It was required to have the holes spaced exactly 1 inch apart and located in a perfectly straight line. Referring to Fig. 1, the edge *A* of the piece of brass *B* was filed true to a 24-inch standard steel straightedge, and the first hole *C* was then drilled 7/16 inch from the edge *A*. A 1-inch hardened scale *D* was next ground away at one corner so that it would not touch a drill in the hole *C* when the square *E* was placed against the drill with the head of the square on the edge *A*. The scale *D* was clamped to the work by means of a small hand clamp *G*.

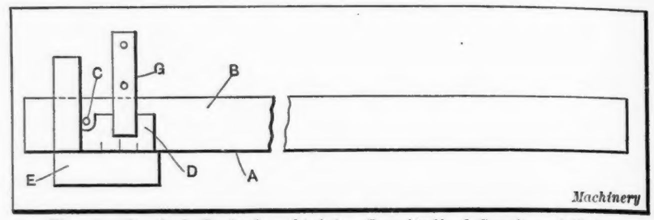


Fig. 1. One-inch Scale for obtaining Longitudinal Spacing of Holes

The work *B* with the scale *D* clamped to it was next placed against the 24-inch steel straightedge shown at *H* in Fig. 2, and a 1/16 brass strip *I* with a hole *J* drilled in it was clamped to the straightedge *H* by means of a hand clamp *K*, a thin strip *L* being placed between the strip *I* and the straightedge *H* so that the combined thickness of the straightedge and strip *L* was slightly greater than the combined thickness of the work *B* and the scale *D*. The straightedge *H* was next clamped to a board *M* by means of two parallel clamps *N*, after which the second hole was drilled in the work through the hole *J* in the strip *I*. In order to locate this hole, the drill was brought into contact with the end of the 1-inch scale *D*, this contact being determined by "sense of touch" as the drill revolved.

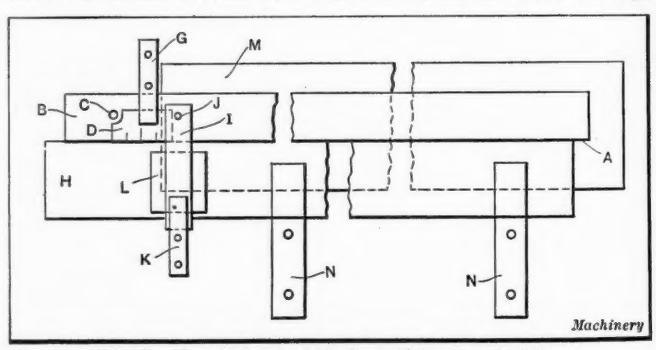


Fig. 2. Twenty-four-inch Scale and Jig for obtaining Transverse Alignment

The work *B* was next removed and the scale *D* unclamped and reclamped in the next position, while the drill was still in the hole *J*, the method of setting being the same as illustrated in Fig. 1. The work was then assembled once more—as illustrated in Fig. 2—and the third hole drilled. All of the hand clamps were so placed that they did not extend over the drilling machine table or interfere with the operation in any way. This sequence of operations was continued until eighteen holes were drilled, and when the work was completed the distance between the holes and their alignment was found to be quite accurate. G. L. C.

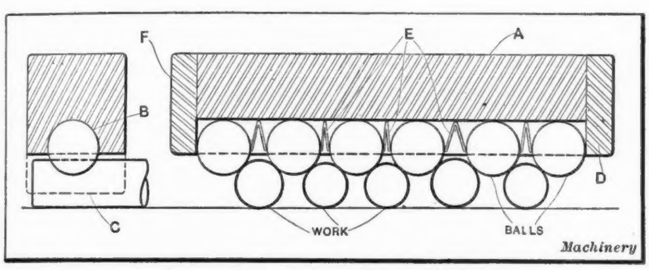
A MULTIPLE CLAMP

In certain operations where quick-acting tools are employed, a decided advantage is obtained by securing several pieces of work with a single clamp. The clamp illustrated herewith was designed with this object in view. Referring to the illustration it will be seen that the design is quite simple, there being none of the complicated floating parts which are often employed in tools of this kind.

The principle upon which this clamp operates is that of allowing the clamping members, which are hardened steel balls, to roll or slide between two fixed ends. Being free to move laterally, these balls adapt themselves to slight variations in the size of the work. The slight irregularity in the center distances caused in this way may produce corresponding inaccuracies in the work, but in most cases the error is negligible.

The main body of the clamp *A* may be made to suit the requirements of the work which is to be handled. This body is bored at *B* to receive the clamping balls. After boring the hole, the stock *C*, which is shown in the illustration by dotted lines, is milled away almost to the horizontal line passing through the center of the hole *B*. Just enough stock is left below the center to prevent the balls from dropping out. One end of the hole is next closed by a plate *D*, after which the balls are put in through the other end, spring spacing pieces *E* being used to maintain the required center distances. The plate *F* is then secured to the opposite end of the clamp.

In operation, the two end balls are held in position by the plates *D* and *F*, and the remaining balls are free to move laterally to adapt themselves to irregularities in the size of the work, the irregularity in size being considerably exaggerated in the illustration. When pressure is applied to the clamp, all of the pieces of work are held equally tight. Instead of using balls, a clamp of this kind could have a dovetailed slot milled in it and hardened rolls with tapered ends, or sliding dovetailed pieces, used for the clamping members.



A Multiple Clamp which is adaptable for Differences in the Size of the Work

Providence, R. I. C. Knowles

IMPROVED DOWELING METHOD FOR DIES

Blanks which have been punched from sheet metal are often perforated by a second operation performed in a piercing die. The blanking and piercing are sometimes accomplished in a single operation, using a gang punch and die, but when accuracy is essential a more common method is to perform the blanking and piercing operations separately.

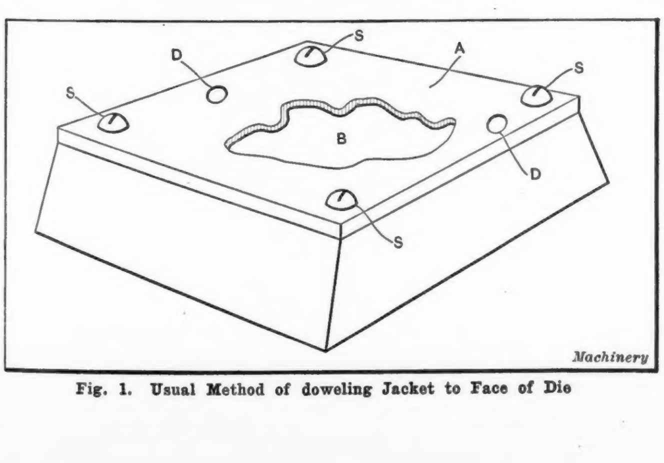


Fig. 1. Usual Method of doweling Jacket to Face of Die

The blank is usually located on the piercing die by means of a gage or "jacket" which consists of a sheet metal piece with a hole through it of the shape and size of the blank. The works fits closely into this gage, which is depended upon to locate the blank and bring it into exactly the desired position for piercing.

The gage is securely held to the die with screws, but screws cannot be depended upon to keep it accurately located; consequently the use of dowel pins is resorted to. The dowel-pin holes are drilled with the gage in place and close fitting dowel pins are driven through it into the die. This method of securing the gage is shown in Fig. 1, where *A* represents the gage with the locating hole *B* cut in it. The screws holding the gage to the die are shown at *S* and the dowel pins at *D*.

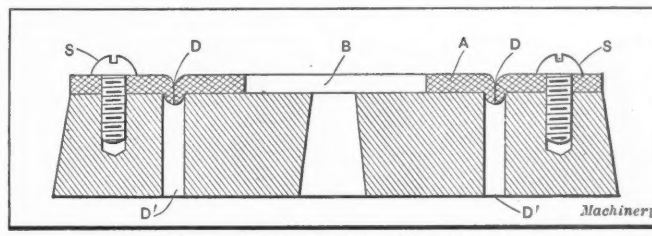
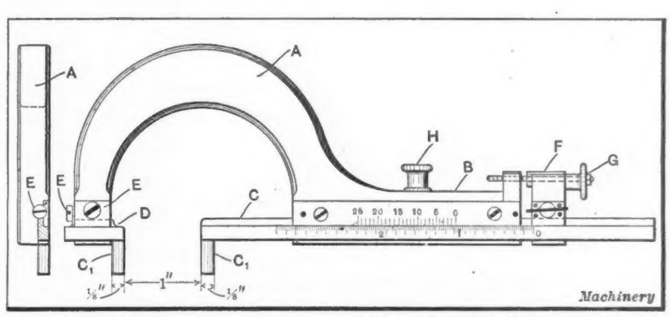


Fig. 2. Improved Method of doweling Jacket in Place

A better method of securing the gage or jacket to the face of the die is shown in Fig. 2. With the gage *A* in position, holes are drilled through it into the die at the points where the dowel pins should be. Two holes 1/16 inch in diameter are drilled in this way. The gage is then removed and the holes *D'* in the die are enlarged to a diameter of 1/8 inch. After hardening the die, the gage is replaced, and after locating it and fastening it in the required position with screws *S*, the point of a center-punch is placed in the 1/16-inch holes and the metal is driven downward into the larger holes in the die. In this way metal plugs *D* which take the place of the dowel pins project from the under side of the gage into the die. It does not take long to locate the gage in place in this way, and, as the plugs are part of it, they will always remain securely in place. F. E. C.

OUTSIDE AND INSIDE VERNIER CALIPER

The accompanying illustration shows a two-inch vernier caliper which is suitable for making both outside and inside measurements. These measurements may be made by using the tool directly or by setting ordinary outside or inside calipers. The following notation is used in marking the different parts of the instrument. *A* is the bow frame which has an extension *B* that supports the guide for the bar *C*. This bar has a projecting jaw C_1 which corresponds with the projecting jaw on the fixed jaw *D*. The fixed jaw is adjusted by means of the screws *E*. The projecting jaws C_1 are finished circular on the outside to provide for measuring internal sizes, while the inside jaws are made flat and are capable of measuring on the outside of either flat or round parts.



A Two-inch Vernier Caliper for Outside and Inside Measurements

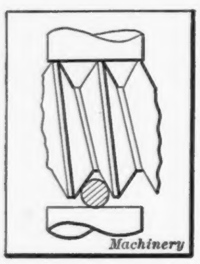
The bar *C* has forty graduations per inch, as usual, with a graduated margin extending beyond the two-inch line to cover a vernier reading in thousandths of an inch. The vernier plate is not made in accordance with the usual method, but is graduated twice the length of the ordinary plate made for a scale with forty graduations per inch. The reason for this is that the vernier plate cut to correspond with each alternate line is easier to read and also provides for getting

dimensions to 0.0005 inch. The adjusting head *F* is provided with a screw *G* for regulating the bar *C*, and *H* is a binding screw which holds the bar in place after the caliper has been set. A valuable feature of the instrument is that it is of rugged construction and not likely to get out of order. The total outside measurement of the jaws C_1 when together is 0.250 inch, so that in setting for inside measurements the vernier reading is 0.250 inch less than the true dimension. A vernier caliper of this kind could be made in different sizes to meet the requirements of various classes of work.

Springfield, Mass. FRANCIS W. CLOUGH

ONE-WIRE SYSTEM FOR MEASURING THREADS

The pitch diameter of screw threads may be measured with ordinary micrometers and one wire arranged as indicated in the accompanying illustration. If the outside diameter of the screw is large or small, allowance must be made for this in measuring. If it is over-size, one-half of the amount that it is over-size must be added to the dimension for the standard outside diameter in the formulas below. If it is under-size, one-half of the amount that it is under-size must be deducted. One wire is much easier to handle than three wires, and when the thread is of very coarse pitch, the end of the micrometer spindle will not reach from one thread to the next as is necessary with the three-wire system. If $M =$ micrometer reading over wire, when pitch diameter is correct, then the formulas for measuring with micrometers and one wire are:



For V-thread,

$$M = 1.5 \times \text{diam. of wire} - \frac{0.866}{\text{no. threads per in.}} + \text{std. outside diam.}$$

For U. S. standard thread,

VALUES OF CONSTANTS USED IN FORMULA FOR MEASURING PITCH DIAMETERS BY THE ONE-WIRE SYSTEM

No. of Threads per Inch	V-Thread 0.866, No. of Threads	U. S. Thread 0.7577, No. of Threads	Whitworth Thread 0.8004, No. of Threads	No. of Threads per Inch	V-Thread 0.866, No. of Threads	U. S. Thread 0.7577, No. of Threads	Whitworth Thread 0.8004, No. of Threads
2¼	0.3849	0.3368	0.3558	20	0.0433	0.0379	0.0400
2⅜	0.3647	0.3241	0.3370	22	0.0394	0.0344	0.0364
2½	0.3464	0.3031	0.3202	24	0.0361	0.0316	0.0334
2⅝	0.3299	0.2887	0.3049	26	0.0338	0.0292	0.0308
2¾	0.3149	0.2755	0.2911	27	0.0321	0.0281	0.0296
2⅞	0.3013	0.2631	0.2784	28	0.0309	0.0271	0.0286
3	0.2887	0.2526	0.2668	30	0.0289	0.0253	0.0267
3¼	0.2665	0.2332	0.2463	32	0.0271	0.0237	0.0250
3½	0.2475	0.2165	0.2287	34	0.0255	0.0223	0.0236
4	0.2165	0.1895	0.2001	36	0.0241	0.0211	0.0223
4½	0.1930	0.1684	0.1779	38	0.0228	0.0199	0.0211
5	0.1732	0.1516	0.1601	40	0.0217	0.0190	0.0200
5½	0.1575	0.1378	0.1456	42	0.0206	0.0181	0.0191
6	0.1444	0.1263	0.1334	44	0.0197	0.0172	0.0182
7	0.1237	0.1083	0.1144	46	0.0189	0.0165	0.0174
8	0.1083	0.0947	0.1001	48	0.0180	0.0158	0.0167
9	0.0962	0.0842	0.0890	50	0.0173	0.0151	0.0160
10	0.0866	0.0758	0.0801	52	0.0167	0.0146	0.0154
11	0.0787	0.0689	0.0728	56	0.0155	0.0135	0.0143
12	0.0722	0.0632	0.0667	60	0.0145	0.0127	0.0184
13	0.0666	0.0583	0.0616	64	0.0135	0.0119	0.0125
14	0.0619	0.0541	0.0572	68	0.0128	0.0117	0.0118
16	0.0541	0.0474	0.0501	72	0.0121	0.0105	0.0111
18	0.0481	0.0421	0.0445	80	0.0108	0.0095	0.0100

Machinery

$$M = 1.5 \times \text{diam. of wire} - \frac{0.7577}{\text{no. threads per in.}} + \text{std. outside diam.}$$

For Whitworth thread,

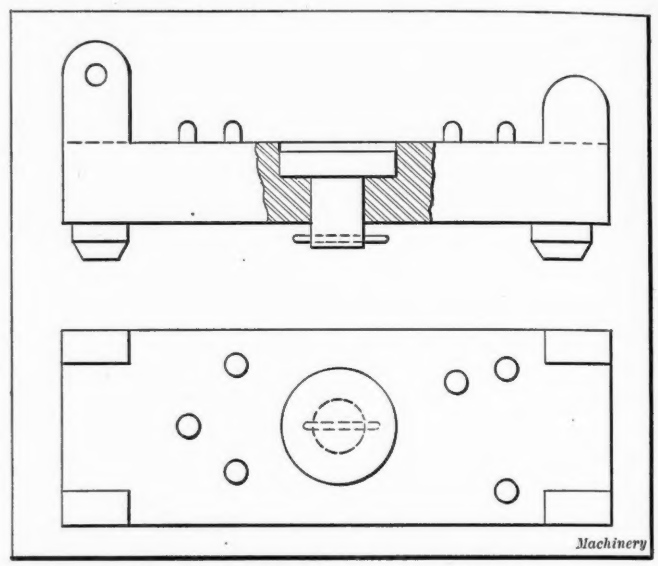
$$M = 1.583 \times \text{diam. of wire} - \frac{0.8004}{\text{no. threads per in.}} + \text{std. outside diam.}$$

The size of the wire used is governed by the pitch and form of thread. The best size to use is that nearest to two-thirds of the pitch. Mistakes can easily be made if too large a wire is used. A wire smaller than 0.6 or larger than 0.9 of the pitch should not be used. The accompanying table gives values of constants which are used in the formulas for measuring pitch diameters of screws by the one-wire system. This method of measuring the threads, of course, presumes that the thread has been cut on centers, so that it is certain to be concentric with the outside diameter of the screw.

Belvidere, Ill. IRVING BANWELL

EJECTING DEVICE FOR USE ON JIGS

The accompanying illustration shows an attachment designed for use on jigs where it is necessary to have the work a tight fit on locating pins. Where this practice is employed and the work has a flat surface in contact with the jig, difficulty is often experienced in removing the piece after the machining operation has been completed. This difficulty is easily overcome by adopting the ejector illustrated herewith. It will be seen to consist of a shoulder pin which is counterbored into the jig and pinned at the opposite side to prevent the shoulder pin from being lost. After the machining operation is completed, the pin is simply tapped up under the work, and in this way the latter is easily knocked off the locating pins.

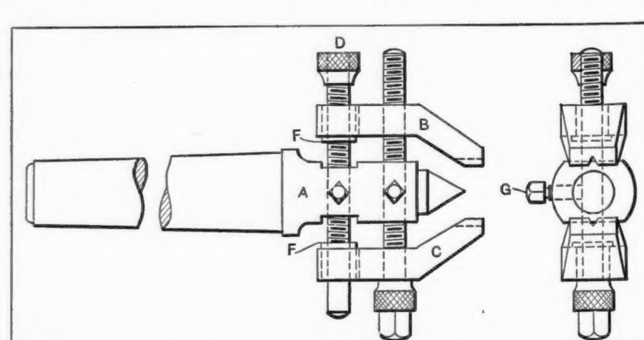


Plug for ejecting Work from Jigs and Fixtures

Montreal, Canada. HERCULES SMART

DRIVER FOR USE IN MILLING MACHINE INDEX HEAD

In the accompanying illustration is shown a driver for use in the milling machine index head for short pieces or for such work as requires to be milled on centers and close to the shank, as for example a short machine tap. Usually, the dog or driver is too much in the way on short work and this tool was made to overcome this trouble. The shank *A* is of tool steel and machined all over, after which the point is hardened, tempered and ground the same as any center. The jaws *B* and *C* are of machine steel, slotted at the ends to



Driver for Short Work where a Regular Dog interferes

receive the shouldered nuts. Jaw *B* is drilled and tapped for the screw *E*, while jaw *C* is drilled and reamed for the same screw. Both jaws are carbonized and hardened. Screw *D* has right- and left-hand threads with the middle portion plain, and the knurled head is a separate piece screwed and pinned on after complete assembly. The screw *E* is of one piece, with a right-hand thread of sufficient length for the extreme adjustments. Nuts *F* are drilled and tapped left and right to an easy fit on the screw *D* and are milled to an easy fit in the slots in the jaws *B* and *C*, having shoulders to take the thrust of the screw *D*. In use, the work is placed on the centers as with regular methods of driving, and the jaws *B* and *C* are brought into contact with the work; the jaws are adjusted the same as a parallel clamp is, and given the final "squeeze" with a wrench on the squared head of screw *E*. Then set-screws *G* are tightened lightly. It will be observed that the jaws are free to "float" until the set-screws have been tightened, which prevents cramping the work.

Hartford, Conn. ERNEST A. RUNGE

BABBITTING MANDRELS

The writer has given considerable time and study to the design of babbitting mandrels, and in the following article three mandrels are described which have been found satisfactory for use in babbitting bearings on a piece-work basis. The operation is satisfactory, very little defective work being produced. Fig. 1 shows assembly and cross-sectional views of a fixture for babbitting bearings of the type shown at *A*. The body of these bearings is made of malleable iron; they are rough-bored, turned and faced, and the bore recessed as shown. A very coarse feed is taken in order to produce a rough surface to which the babbitt will adhere firmly. There were a large number of these bearings to be lined and on this account it was found desirable to use a multiple fixture, the design finally developed being equipped with four mandrels as shown in the illustration. The mandrels are set in a cast-iron base *B*. It will be seen that the mandrel consists of two parts, the body *C* and a dovetailed piece *F* which has a small block *G* mounted in it. This block forms the oil groove in the bearing. The base of the fixture is bored in such a way that the mandrel and bearing are held concentric, and after the work has been set up as shown in the cross-sectional view everything is ready for pouring the babbitt. After the babbitt has been poured and given time to set the lever *D* is struck a sharp blow; this loosens the main part of the mandrel and enables it to be readily removed by inserting a wire in the screw-eye *E*. The dovetailed piece *F* is next removed by giving it a slight tap toward the center of the bearing. The bearing can then be removed from the fixture, and another casting set up in its place ready to be babbitted.

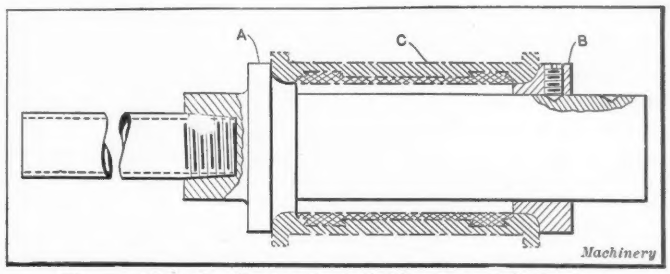


Fig. 3. Adjustable Mandrel for babbitting Plain Half Bearings

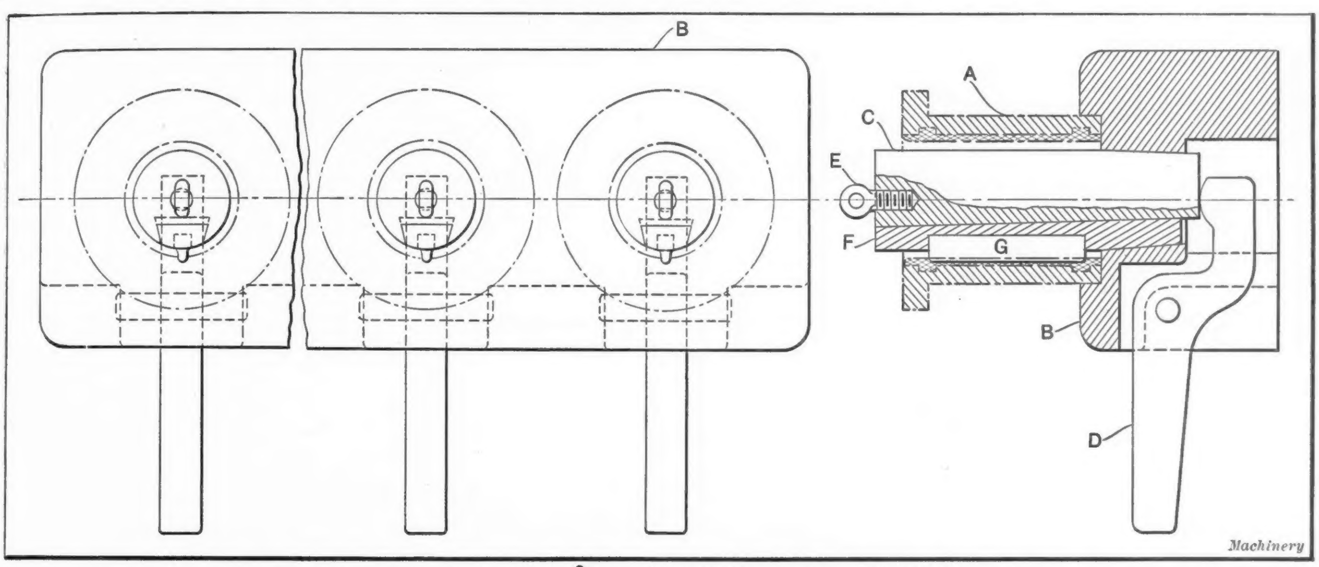


Fig. 1. Fixture equipped with Four Mandrels for babbitting Bearings with Straight Oil Groove

Fig. 2 shows a mandrel for babbitting bearings in which the oil grooves are set at an angle to each other as shown at *A*. This mandrel was made similar to the one shown in the preceding illustration and can be used in connection with the same base *B*.

A mandrel is shown in Fig. 3 that is used for babbitting half bearings of the type shown at *C*, these bearings having no oil grooves. The mandrel consists of a center piece *A* which is provided with a handle made of ½-inch pipe at one end and a sliding collar *B* at the opposite end. The position of this collar can be adjusted for different lengths of bearings of a given diameter. It will be evident that the collar is held in position by a set-screw. The collars are turned to a close fit in the bearing castings so that they will not allow the metal to run out. These particular bearings were made of bronze castings and babbitted in the rough. The bearings were made in several different lengths, and by making the mandrel to suit the longest it may be used with equally good results for the shorter ones.

All three styles of bearings were babbitted on a piece-work basis with entirely satisfactory results. We generally had three or four of these fixtures set up on the bench, and by having a boy assemble the fixtures while the man did the pouring, a very satisfactory rate of production was attained. The best results are obtained by having all parts of the fixture and work at the same temperature. A good method is to lay as many of the bearing castings as possible around the top of the furnace in which the babbitt is melted.

G. E. P.

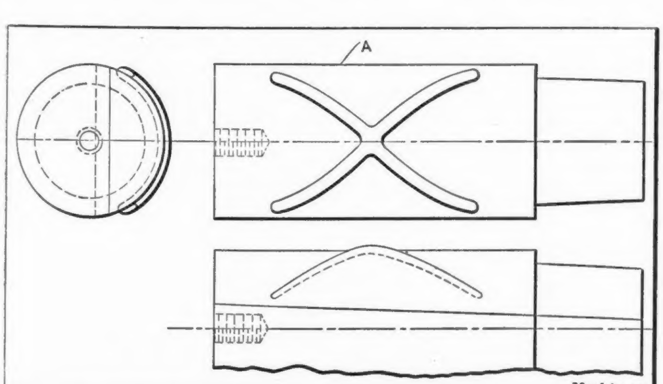


Fig. 2. Mandrel for babbitting Bearings with Crossed Oil Grooves

SPRING LATCH FOR JIG COVER

A hinged jig cover may be conveniently held in place by means of a spring latch of the form shown in Fig. 1, which is semi-automatic in its action. In this illustration, the body of the jig is shown at *A* and the hinged cover at *B*. This cover swings on the pivot *C*, and drops onto the latch *D* which takes the place of the locking screw arrangement shown in Fig. 2. In cases where the cover is merely used to carry bushings, a latch of this kind is entirely satisfactory, although it is not recommended for use on jigs where screws for hold-

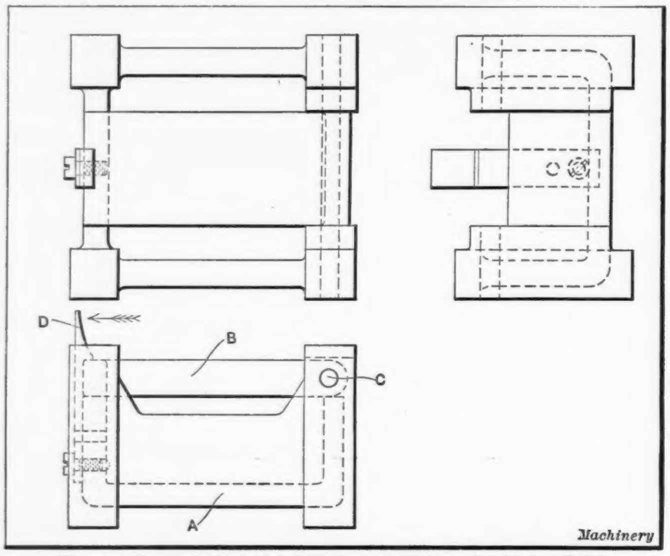


Fig. 1. Type of Jig which has Cover held down by Spring Latch

ing down the work are carried by the cover. The method of using is evident from the illustration. To swing the cover clear of the work in the jig, the latch *D* is pushed back in the direction of the arrow. After the cover has been raised, the latch springs back into place ready to catch over the top of the cover, when it is dropped back onto the jig. When the

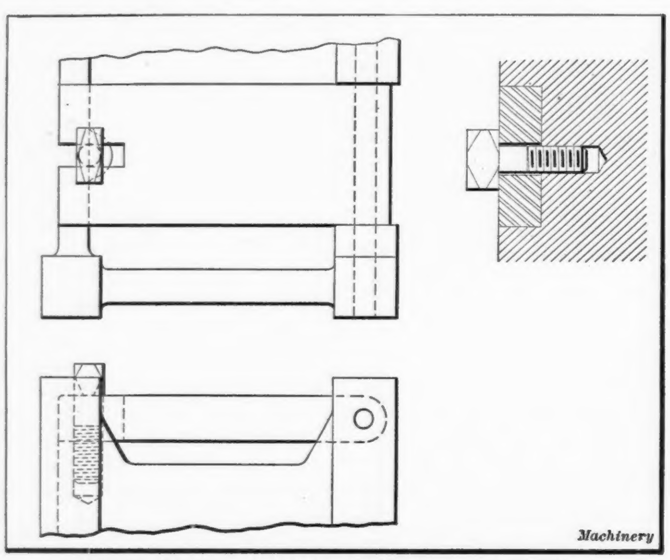


Fig. 2. Jig Cover locked by Quarter Turn Screw Buckle

cover is dropped, the latch catches it automatically, requiring no attention from the operator.

F. SERVER

STRADDLE MILL KINK FOR CAST IRON WORK

When facing off the edges of a cast-iron piece with straddle mills, it will be noticed that the last corner at the end of the cut almost invariably breaks off. This condition is more marked if the edge at an angle to the face being milled has already been machined. The rounded corners on rough castings do not break as easily. Various remedies are used to avoid this difficulty, among which may be mentioned filing the corners of the work off on a bevel, supporting the work close up to the cut, or reducing the cut and feed. All of these methods, however, are but partially successful. The best "stunt" that the writer knows of is to take off the sharp corners of the cutter, *i. e.*, grind the corner off to an angle of 45 degrees, making a flat of about 1/16 inch. When this practice is followed the breaking and chipping of the work will be practically eliminated.

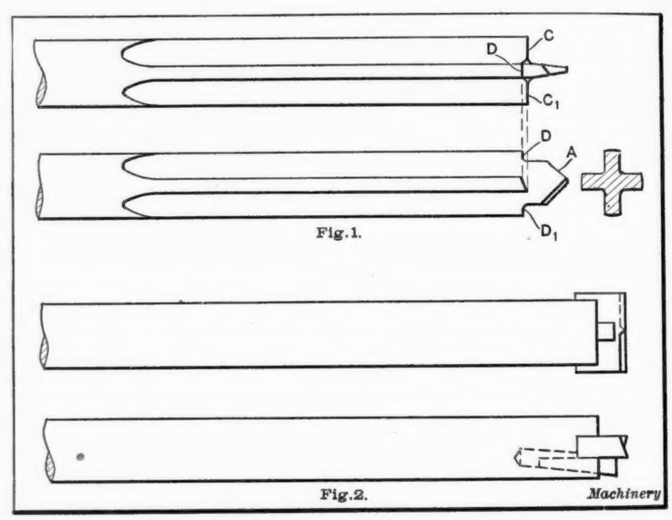
Middletown, N. Y. DONALD A. HAMPSON

[In facing a piece of work with straddle milling cutters, the stock left on the work at the time the cutters are approaching the completion of a cut is in the form of two cantilever beams. We know that the greatest stress in a cantilever is at the point of support, and by grinding off the corners of the cutters, as recommended, the cross-sectional area of this point of support is greater than that of any other cross-section. The additional strength provided in this way is sufficient to prevent the corner from breaking off.—EDITOR.]

DRILL AND BORING-BAR FOR PULLEYS

A drill for drilling holes in solid hubs of pulleys is shown in Fig. 1. The hole for which this particular drill was used is ¾ inch in diameter, which is too small to core and true by boring. We tried twist drills and flat drills, but if the drill encountered a blowhole in the casting, it would run out of true. The tool now being used is made of high-speed steel and it has drilled about one thousand pulleys and is still doing business. As the illustration shows, it is milled to a cross-shaped section which makes it very stiff.

The point of the drill *A* is ground like an ordinary flat drill and it makes a smaller hole than the main drill body. The two ends *D* and D_1 are ground below the cutting edges *C* and C_1 so that the stock left by the point *A* is removed by these two edges. Obviously, the ends *D* do not cut. If the drill is



Figs. 1 and 2. Drill and Boring-bar for Pulleys

started true and fed in until the two corners *C* have entered, the hole acts as a bushing and the drill cannot run out, even though it enters a blowhole. Of course, the point *A* must be ground centrally and the edges *C* must be ground so that they both cut and do not make the hole larger than the drill body. This drill is 11/16 inch in diameter and is used in a lathe.

After a hole is drilled in a pulley, a boring-bar like the one shown in Fig. 2, is used for truing the hole. The corners of the cutter are ground square and the cutter, which is of high-speed steel, is held by a half-round key. The hole for this key is drilled on a slight angle before the slot is milled for the cutter. When a new cutter is to be inserted, the old one is driven out, which causes the key to fall out. The hole in the pulley is finished by reaming.

B. J. F.

* * *

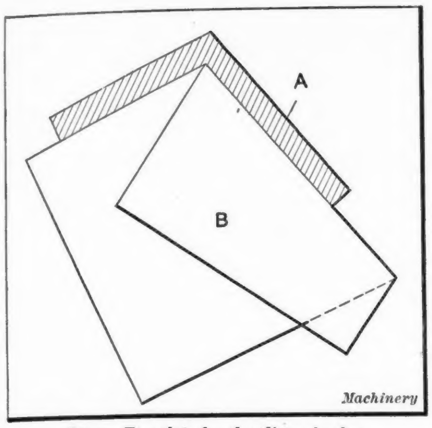
Persons who look upon the increase in gold production as chiefly responsible for the increased cost of living will regret to hear that important new deposits of gold have been found in Siberia (already one of the leading gold-producing regions of the world), and that these will rank among the richest fields in Siberia. According to that school of economists who put the blame on gold, if nature had made it as common as iron, we would all be starving.

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

AN ANGLE BENDING KINK

It frequently happens that the machinist is required to bend a piece of sheet iron, brass or other stock to a certain angle, but the draftsman has omitted to give this angle on the drawing from which the machinist is working. In such cases, the time-honored method of bending a piece in the vise and then trying it on the drawing is often employed. Owing to greasy hands and to oil on the stock, the drawing soon becomes so dirty that it is unreadable.



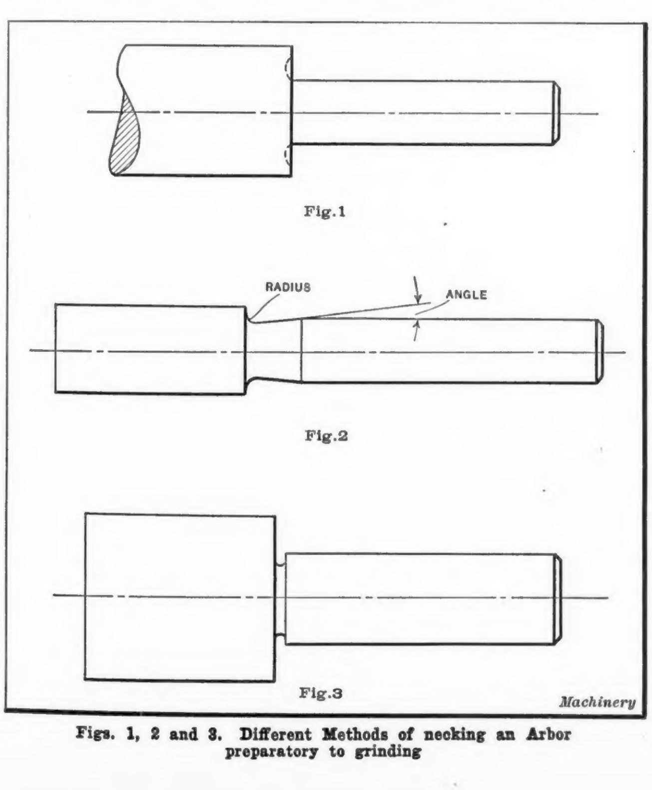
Paper Templet for bending Angles

A much cleaner method, which the writer has employed on a variety of work, consists of laying a piece of paper over the drawing with one edge coinciding with one side of the required angle. The paper is then folded as shown in the accompanying illustration, so that a templet of the required angle is formed. The stock is now bent in the usual way until it fits accurately against the templet. In the illustration, the cross-sectional view *A* represents the angle, as shown on the drawing from which the machinist is working, and *B* represents the paper templet.

East Orange, N. J. GEORGE GARRISON

A NECKING KINK

The accompanying illustrations show different methods of necking an arbor preparatory to grinding it. When there is a large shoulder at the end of the arbor, the most satisfactory method of necking is that shown in Fig. 1. Where the shoulder is relatively small, the method illustrated in Fig. 2 will give very satisfactory results. The method shown in Fig. 3 is in quite general use, but this is decidedly poor practice. It weakens the shaft or arbor very materially owing to the fact that the neck is cut in such a way that it reduces the cross-section at the point where the greatest strain is likely to be experienced.

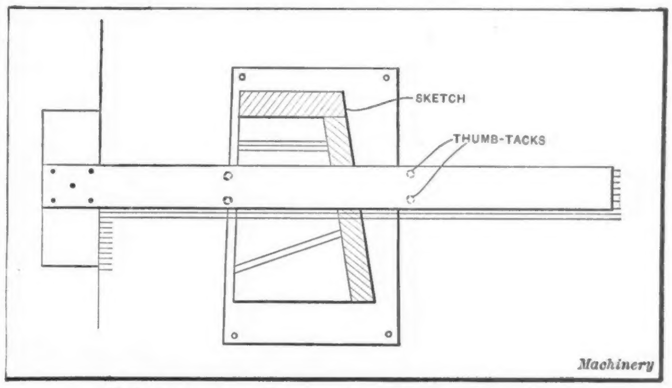


Figs. 1, 2 and 3. Different Methods of necking an Arbor preparatory to grinding

Lynn, Mass. R. F. Pohle

PROTECTING DRAWINGS

A method by which drawings may be protected against the smudging action of the T-square consists of sticking four thumb-tacks in the under side of the blade so that it will not come into contact with the portion of the drawing that it is desired to protect. This method will be found particularly useful where a pencil drawing is made, as it will prevent the pencil lines being rubbed by the T-square. It will also guard the drawing against being soiled by a dusty square, and the same arrangement will be found effective in preventing the ink from running under the edge of the square.

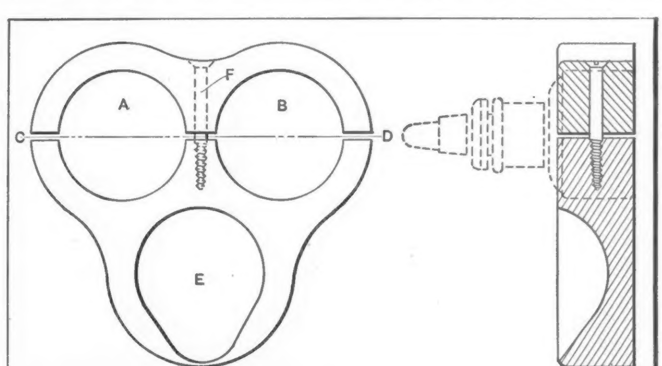


Method of raising T-square from Surface of Drawings

Washington, D. C. A. P. CONNOR

HOLDER FOR THUMB-TACKS AND INK BOTTLES

The illustration presented herewith shows a holder for a draftsman's ink bottles and thumb-tacks which can be easily made if the instructions are carefully followed. The outline, the holes *A* and *B* for the ink bottles and hole *E* for the thumb-tacks are laid out on a piece of one-inch board with the grain of the wood running parallel to the line *CD*. The holes are then cut out with a fine band-saw, the saw being first run along the line *CD*, after which the semi-circles are cut out. The hole *E* for the thumb-tacks is next made with a spoon gouge. The hole is then drilled for the screw *F* which holds the back in place, after which the parts are sandpapered and shellacked. When the shellac has dried the bottles are put in position and the back screwed up tight against them.



Tray for holding a Draftsman's Thumb-tacks and Ink Bottles

Davenport, Ia. R. H. RICHARDSON

* * *

The Massachusetts Institute of Technology has erected an aero-dynamic laboratory and has also instituted courses in the study of this science. It is the first technical institution in the country fitted to instruct students thoroughly in the subject of aeronautics.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

LIMITS IN SPECIFYING BAND, BAR AND PLATE IRON AND WIRE

A. S. H.—We have a large drafting-room, and the following questions often come up during the day. There seems to be a difference of opinion on the practice of specifying the materials mentioned and we would appreciate an opinion from the readers of MACHINERY as to limitations of these products. 1. What are the limits within which to specify band or bar iron? 2. Is there a correct thickness for specifying bar iron where the thickness of band iron stops and bar iron starts? 3. Where does the diameter of wire stop and rods begin? 4. In specifying plate how wide does iron have to be before it becomes a plate?

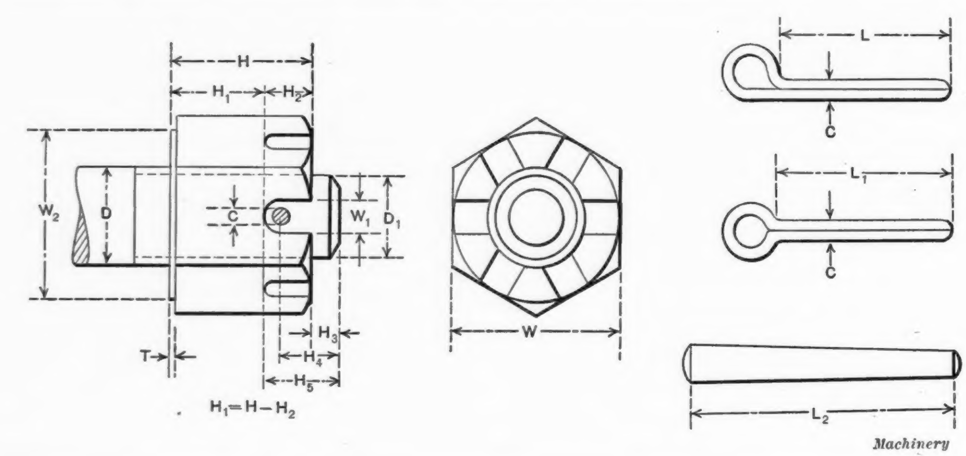
The questions are submitted for opinions of the readers.

DIMENSIONS OF CASTLE NUTS ADOPTED BY A. R. M. M. ASSOCIATION

A. L. D.—What are the dimensions of castellated nuts and thin castellated nuts adopted by the American Railway Master Mechanics' Association?

A.—Dimensions of castellated nuts and thin castellated nuts recommended by the American Railway Master Mechanics' Association at the Atlantic City meeting June, 1912, are given in the accompanying tables compiled by the Brightman Mfg. Co., Columbus, Ohio. Table II on the following page gives the dimensions of castle nuts and thin castle nuts as derived by the formulas, being closely in agreement, of course, with the data in Table I.

TABLE I. DIMENSIONS OF CASTLE NUTS AND THIN CASTLE NUTS*



Recommended Dimensions, Inches

Nut	D	Diameter of screw	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2
		No. of threads per inch U. S. standard castle and thin castle nut	13	11	10	9	8	7	7	6	6	5 1/2	5	5	4 1/2	4 1/2	4	4	3 1/2	3 1/2	3 1/4
		No. of threads per inch for special thin castle nut	13	11	10	9	8	8	8	8	8	8	8	8	8	8	8	8	8	6	6
	W	Diameter across flats, rough size	7/8	1 1/16	1 1/4	1 7/16	1 5/8	1 13/16	2	2 3/16	2 3/8	2 9/16	2 3/4	2 15/16	3 1/8	3 1/2	3 7/8	4 1/4	4 5/8	5	5 3/8
	W_2	Diameter facing collar	13/16	1	1 3/16	1 3/8	1 9/16	1 3/4	1 15/16	2 1/8	2 5/16	2 1/2	2 11/16	2 7/8	3 1/16	3 7/16	3 13/16	4 3/16	4 9/16	4 15/16	5 5/16
	T	Thickness facing collar	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32	1/32
	H	Thickness castle nut, rough	13/16	15/16	1 1/16	1 3/16	1 5/16	1 7/16	1 9/16	1 11/16	1 13/16	1 15/16	2	2 1/8	2 3/16	2 3/8	2 9/16	2 3/4	2 15/16	3 1/8	3 5/16
	H	Thickness castle nut, finished	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	1 15/16	2 1/16	2 1/8	2 5/16	2 1/2	2 11/16	2 7/8	3 1/16	3 1/4
	H	Thickness of thin castle nut, rough	13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	1 3/8	1 3/8	1 7/16	1 7/16	1 1/2	1 9/16	1 5/8	1 11/16	1 3/4	1 13/16
	H	Thickness of thin castle nut, finished	3/4	13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	1 5/16	1 3/8	1 3/8	1 7/16	1 1/2	1 9/16	1 5/8	1 11/16	1 3/4
		Number slots in castle	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	W_1	Width of slot in castle	1/4	1/4	1/4	5/16	5/16	3/8	3/8	3/8	3/8	3/8	7/16	7/16	7/16	7/16	9/16	9/16	5/8	5/8	5/8
	H_2	Depth of slot in castle	3/8	3/8	3/8	7/16	7/16	1/2	1/2	1/2	1/2	1/2	9/16	9/16	9/16	9/16	11/16	11/16	3/4	3/4	3/4
Bolt	C	Diameter of cotter-pin hole in bolt	3/16	3/16	3/16	1/4	1/4	5/16	5/16	5/16	5/16	5/16	3/8	3/8	3/8	3/8	1/2	1/2	1/2	1/2	1/2
	H_3	Projection of bolt beyond top of nut	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	1/4	1/4	1/4	1/4	5/16	5/16	5/16	5/16	3/8	3/8	3/8
	D_1	Diameter of reduced end of bolt	3/8	7/16	9/16	11/16	13/16	7/8	1	1 1/8	1 1/4	1 5/16	1 7/16	1 9/16	1 11/16	1 7/8	2 1/8	2 5/16	2 9/16	2 3/4	3
	H_5	Length of reduced end of bolt	9/16	9/16	9/16	5/8	5/8	3/4	3/4	3/4	3/4	3/4	13/16	13/16	7/8	7/8	1	1	1 1/8	1 1/8	1 1/8
	H_4	Distance from center of cotter-pin hole to end of bolt	3/8	3/8	3/8	7/16	7/16	1/2	1/2	1/2	1/2	1/2	9/16	9/16	5/8	5/8	11/16	11/16	13/16	13/16	13/16
Cotter	C	Nominal diameter of cotter pin	3/16	3/16	3/16	1/4	1/4	5/16	5/16	5/16	5/16	5/16	3/8	3/8	3/8	3/8	1/2	1/2	1/2	1/2	1/2
	L	Length of player cotter pin	7/8	1	1 1/4	1 1/2	1 1/2	1 3/4	1 3/4	2	2	2	2 1/2	2 1/2	3	3	3 1/2	3 1/2	4	5	5
	L_1	Length of common cotter pin	1 1/4	1 1/2	1 3/4	2	2	2 1/4	2 1/2	2 1/2	3	3	3 1/2	3 1/2	3 1/2	4	5	5	5	6	6
Taper Pin		No. of taper pin	2	2	2	4	4	6	6	6	6	6	6	6	7	7	8	8	9	9	9
	L_2	Length of taper pin	1 1/4	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/4	3 1/2	3 3/4	4 1/4	4 1/2	5	5 1/4	5 3/4

Machinery

* Adopted 1912 by the American Railway Master Mechanics Association

TABLE II. DIMENSIONS OF CASTLE NUTS AND THIN CASTLE NUTS

Formulas	Dimensions obtained from Formulas																			
D	Diameter of screw.....	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2
$W = \frac{3D}{2} + \frac{1''}{8}$	Diameter across flats of rough nut...........	7/8	1 1/16	1 1/4	1 7/16	1 5/8	1 13/16	2	2 3/16	2 3/8	2 9/16	2 3/4	2 15/16	3 1/8	3 1/2	3 7/8	4 1/4	4 5/8	5	5 3/8
$H = D + \frac{5''}{16}$	Thickness of castle nut 1/2" to 1 1/2" diam., rough.	13/16	15/16	1 1/16	1 3/16	1 5/16	1 7/16	1 9/16	1 11/16	1 13/16	..	..	..	..	..	..	..	..	..	..
$H = \frac{3D}{4} + \frac{11''}{16}$	Thickness of castle nut 1 1/2" to 3 1/2" diam., rough.	..	..	..	..	..	..	..	..	1 13/16	1 29/32	2	2 3/32	2 3/16	2 3/8	2 9/16	2 3/4	2 15/16	3 1/8	3 5/16
$H = D + \frac{1''}{4}$	Thickness of castle nut 1/2" to 1 1/2" diam., finished................	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	..	..	..	..	..	..	..	..	..	..
$H = \frac{3D}{4} + \frac{5''}{8}$	Thickness of castle nut 1 1/2" to 3 1/2" diam., finished................	..	..	..	..	..	..	..	..	1 3/4	1 27/32	1 15/16	2 1/32	2 1/8	2 5/16	2 1/2	2 11/16	2 7/8	3 1/16	3 1/4
$H = \frac{D}{2} + \frac{9''}{16}$	Thickness of thin castle nut 1/2" to 1 1/2" diam., rough...............	13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16	..	..	..	..	..	..	..	..	..	..
$H = \frac{D}{4} + \frac{15''}{16}$	Thickness of thin castle nut 1 1/2" to 3 1/2" diam., rough................	..	..	..	..	..	..	..	..	1 5/16	1 11/32	1 3/8	1 13/32	1 7/16	1 1/2	1 9/16	1 5/8	1 11/16	1 3/4	1 13/16
$H = \frac{D}{2} + \frac{1''}{2}$	Thickness of thin castle nut, 1/2" to 1 1/2" diam., finished.........	3/4	13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4	..	..	..	..	..	..	..	..	..	..
$H = \frac{D}{2} + \frac{7''}{8}$	Thickness of thin castle nut, 1 1/2" to 3 1/2" diam., finished.............	..	..	..	..	..	..	..	..	1 1/4	1 9/32	1 5/26	1 11/32	1 3/8	1 7/16	1 1/2	1 9/16	1 5/8	1 11/16	1 3/4
$W_1 = \frac{D}{8} + \frac{3''}{16}$	Width of slot in castle.	1/4	17/64	9/32	19/64	5/16	21/64	11/32	23/64	3/8	25/64	13/32	27/64	7/16	15/32	1/2	17/32	9/16	19/32	5/8
$H_2 = \frac{D}{8} + \frac{5''}{16}$	Depth of slot in castle..	3/8	25/64	13/32	27/64	7/16	29/64	15/32	31/64	1/2	33/64	17/32	35/64	9/16	19/32	5/8	21/32	11/16	23/32	3/4
$C = \frac{D}{8} + \frac{1''}{8}$	Diam. of cotter-pin and diam. of hole in bolt.	3/16	13/64	7/32	15/64	1/4	17/64	9/32	19/64	5/16	21/64	11/32	23/64	3/8	13/32	7/16	15/32	1/2	17/32	9/16
$L = \frac{19D}{16} + \frac{1''}{4}$	Length of player cotter-pin..................	27/32	1	1 9/64	1 19/64	1 7/16	1 37/64	1 47/64	1 7/8	2 1/32	2 3/16	2 21/64	2 15/32	2 5/8	2 59/64	3 7/32	3 33/64	3 13/16	4 7/64	4 13/32
$L_1 = \frac{3D}{2} + \frac{1''}{2}$	Length of common cot ter-pin...............	1 1/4	1 7/16	1 5/8	1 13/16	2	2 3/16	2 3/8	2 9/16	2 3/4	2 15/16	3 1/8	3 5/16	3 1/2	3 7/8	4 1/4	4 5/8	5	5 3/8	5 3/4

Machinery

THE SOCIOLOGICAL SIDE OF INDUSTRY

Evidence accumulates that America is awakening to a better sense of social justice and the need of economic reform. Great trusts and private monopolies of public utilities are being dissolved or regulated by public commissions, and while competition in business may be wasteful, the need of equal opportunities for all requires the strengthening of laws aimed at methods which interfere with freedom in trade and manufacture.

For many years the unfair and inadequate "fellow servant" rule in law made society practically helpless in many states to protect labor from the risks of life and limb incident to railroading, mining, building and manufacturing. The labor compensation law passed by the New York State Legislature last year is but one of several enacted by the states to place the burdens on the industry affected, making it responsible for the maintenance of its injured and the families of its killed. The ultimate effect should be to reduce preventable accidents to a minimum. Machinery will be safeguarded and dangerous manufacturing conditions eliminated. Much progress has already been made, and men are being taught to be careful of themselves and of their fellow workmen.

Another source of encouragement to the social worker is the more liberal spirit of employers toward labor. The example of the Ford Motor Co., unwise perhaps in some respects, must have a tremendous influence on the betterment of relations of capital and labor. Libraries, free and otherwise, are useful to inform the mind and stimulate ambition; but better food and clothes and houses as a result of faithful daily toil are of still greater value to the mass of workers.

Welfare work pays when rightly directed. Decent living conditions are necessary for the healthful condition of mind and body essential to good working efficiency. In places where very little in the way of healthy recreations and amusements is available to the people, it is decidedly to the interest of local manufacturing concerns to provide them in such manner as to conserve the independence and self-respect of those benefited. The whole modern movement tends to elevate the ideals of society and to place labor on a higher plane by recognizing human rights and abolishing injustices rooted in antiquated legal practices. That the conditions which have developed in America during the past thirty years are out of place in, and probably dangerous to, a democratic form of government, the thoughtful and unprejudiced observer will admit. A brighter day has dawned for industry. The new social spirit and the new freedom will give heart to American inventors and workers generally, and will encourage the enterprising spirits on every level to make for themselves a place in the industrial and commercial world.

* * *

In experiments undertaken by the Technical Institute of Berlin, Germany, it has been ascertained that the most suitable angle of clearance back of the cutting edge on twist drills, for drilling steel and cast iron, is 6 degrees at the circumference of the drill, this angle increasing, in general, to from 20 to 24 degrees toward the center of the drill. Such an angle can generally be obtained by commercial twist drill grinding machines.

ANNUAL CONVENTIONS M. C. B. AND A. R. M. M. ASSOCIATIONS

The forty-eighth annual convention of the Master Car Builders' Association and the forty-seventh annual convention of the American Railway Master Mechanics' Association were held in Atlantic City, June 10-12 and June 15-17, respectively. Simultaneously, the Railway Supply Manufacturers' Association exhibited machinery and tools covering an area on Young's New Pier of nearly two acres or 82,000 square feet. The exhibits comprised railway supplies in general, including locomotive, car, track and shop materials, tools, machines, etc. The machine tool exhibit was an important part of the show and it attracted much attention. Each year this showing of machines, tools, cutters, etc., for locomotive repair shops becomes of greater and greater diversity and importance. Railway shops in general are large potential markets for machine tools and allied products, and the growth in size and power of locomotives requires the best and most efficient machine tools.

The Master Car Builders' Association convention program was made up, as usual, of technical papers, topical discussions and reports of committees, being in part as follows:

June 10. Revision of Standards and Recommended Practice; Train Brake and Signal Equipment; Brake Shoe and Brake Beam Equipment; Car Wheels.

June 11. Coupler and Draft Equipment; Safety Appliances; Rules for Loading Materials; Interline Inspection; Car Trucks; Train Lighting and Equipment; Tank Cars.

June 12. Damage to Freight by Unloading Machines; Specifications and Tests for Materials; Car Construction; Retirement of 40,000 and 50,000 Pound Capacity Cars from Interchange Service.

The following officers were elected for the Master Car Builders' Association: F. F. Gaines, president; E. W. Pratt, first vice-president; William Schlafge, second vice-president; F. H. Clark, third vice-president; Angus Sinclair, treasurer; C. F. Giles, M. K. Barnum and John Purcell, executive committee.

The program of the American Railway Master Mechanics' Association included the following technical papers and discussions:

June 15. Mechanical Stokers; Revision of Standards; Safety Appliances; Dimensions for Flange and Screw Couplings for Injectors, by O. M. Foster; Motors for Railway Shops, by B. F. Kuhn.

June 16. Locomotive Headlights; Design, Construction and Maintenance of Locomotive Boilers; Standardization of Tinware; Superheater Locomotives; Use of Special Alloys and Heat-treated Steel in Locomotive Construction; Review of the Work done by Other Mechanical Organizations, by Dr. Angus Sinclair.

June 17. Smoke Prevention; Revision of Standard Efficiency Tests of Locomotives; Revision of Air Brake and Train Signal Instructions; Train Resistance and Tonnage Rating; Fuel Economy; Tests of Schmidt Superheater and Brick Arch, by H. W. Coddington.

The following officers were elected for the American Railway Master Mechanics' Association: D. F. Crawford, president; D. R. MacBain, first vice-president; R. W. Burnett, second vice-president; C. E. Chambers, third vice-president; John S. Lentz, treasurer; R. E. Smith, J. C. Fritts and H. T. Bentley, executive committee.

The exhibitors comprised two hundred and sixty-nine concerns, among whom were the following showing machine tools, taps, cutters, steel and other machine shop supplies:

Acme Machine Tool Co., Cincinnati, Ohio. Cincinnati-Acme 3¼-inch by 36-inch flat turret lathe; 18-inch geared head universal turret lathe.

Alston Saw & Steel Co., Folcroft, Pa. Alston hacksaw blades.

American Tool Works Co., Cincinnati, Ohio. "American" 36-inch heavy pattern, high duty lathe; 16-inch tool-room lathe; 6-foot radial drilling machine; 2-foot radial drilling machine; 24-inch crank shaper.

Armstrong-Blum Mfg. Co., Chicago, Ill. "Marvel" high-speed hacksaw machines.

Baker Bros., Toledo, Ohio. Baker high-speed, heavy duty drilling machine.

Baush Machine Tool Co., Springfield, Mass. New design 5-foot radial drilling machine; Lassiter staybolt turning and threading machine; automatic staybolt drilling machine.

C. H. Besly & Co., Chicago, Ill. Besly patternmaker's disk grinder; motor-driven disk grinder; forged taps; pressed steel ring wheel chucks; spiral circles; etc.

Hermann Boker & Co., New York City. "Novo" and "Novo Superior" high-speed steels, etc.

W. L. Brubaker & Bros., Millersburg, Pa. Screw plates, taps, dies, reamers, etc.

C. & C. Electric & Mfg. Co., Garwood, N. J. Electric arc welding outfit in operation.

Carborundum Co., Niagara Falls, N. Y. Carborundum and aloxite wheels and abrasives.

Cayuta Mfg. Co., Sayre, Pa. Ball bearing screw jacks, etc.

Celfor Tool Co., Buchanan, Mich. "Celfor" drills, reamers, countersinks, cutters, etc.

Cincinnati Bickford Tool Co., Cincinnati, Ohio. "Cincinnati-Bickford" 24-inch upright drill with tapping attachment; 5-foot plain radial drilling machine.

Cincinnati Milling Machine Co., Cincinnati, Ohio. "Cincinnati" high power milling machine equipped with stream lubrication; high power vertical milling machine; cutter and tool grinder.

Cincinnati Planer Co., Cincinnati, Ohio. "Cincinnati" 36-inch by 36-inch by 8-foot heavy pattern planer with four heads and reversible motor drive.

Davis Boring Tool Co., St. Louis, Mo. Boring bars for car wheels and boring tools and reamers.

Duff Mfg. Co., Pittsburg, Pa. Hydraulic jacks, etc.

Eagle Glass & Mfg. Co., Wellsburg, W. Va. Steel oil cans, oilers, oil carriers, etc.

Earle Gear & Machine Co., Philadelphia, Pa. "Lea-Simplex" cold saws.

Electric Controller & Mfg. Co., Cleveland, Ohio. Lifting magnets and automatic machine tool controllers and starters.

Goldschmidt Thermit Co., New York City. Thermit and samples of thermit welding.

Edwin Harrington Son & Co., Inc., Philadelphia, Pa. Multiple-spindle drilling machine, hoists and travelers.

Hollands Mfg. Co., Erie, Pa. Machinists' vises.

Independent Pneumatic Tool Co., Chicago, Ill. "Thor" pneumatic tools.

Ingersoll-Rand Co., New York City. "Little David" pneumatic tools.

International Oxygen Co., New York City. Oxy-hydrogen welding and cutting equipment.

Jones & Lamson Machine Co., Springfield, Vt. Flat turret lathes.

Landis Machine Co., Waynesboro, Pa. Motor-driven bolt cutters, die heads, etc.

Landis Tool Co., Waynesboro, Pa. Self-contained plain grinding machine.

R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Motor-driven 25-inch heavy-duty engine lathe; heavy-duty plain milling machine; 21-inch quick change engine lathe, three-step cone and double friction back gears; universal cutter and tool-room grinder; 16-inch portable fitting lathe for locomotive roundhouses.

Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. 16-inch selective head universal tool-room lathe; 18-inch selective head universal manufacturing engine lathe; 30-inch heavy forge lathe; 48-inch selective head engine lathe.

Lutz-Webster Engineering Co., Inc., Philadelphia, Pa. Lutz universal compression ratchet, compression lathe dog, drilling press or "old man" with fixed and swivel arms.

Newton Machine Tool Works, Inc., Philadelphia, Pa. Locomotive link grinding machine; cold metal sawing machine.

Niles-Bement-Pond Co., New York City. Niles combined journal turning and axle turning lathe; P. & W. 10-inch vertical shaper.

R. D. Nuttall Co., Pittsburg, Pa. Cut gears and pinions and demonstration of heat-treatment of steel.

Henry Pels & Co., New York City. Punching and shearing machines for I-beams, channels, angles, etc.

Reed Mfg. Co., Erie, Pa. Machinists' vises, etc.

Reliance Electric & Engineering Co., Cleveland, Ohio. Adjustable speed and constant speed direct current motors and alternating current constant speed motors.

Joseph T. Ryerson & Son, Chicago, Ill. "Ni-chrome" steel and high-speed twist drills.

William Sellers & Co., Inc., Philadelphia, Pa. Car wheel boring machine with automatic chuck; lineshaft hangers and bearings.

Warner & Swasey Co., Cleveland, Ohio. Universal hollow hexagon turret lathes.

Watson-Stillman Co., Aldene, N. J. Hydraulic jacks, etc.

Wiener Machinery Co., New York City. "Oeking" combination punch, shear and bar angle cutter; universal radial drilling machines.

Wiley & Russell Mfg. Co., Greenfield, Mass. Taps, dies and screw cutting tools and machinery.

T. A. Wilson & Co., Reading, Pa. Safety glass spectacles for machine shop and foundry works, etc.

Wilmarth & Morman Co., Grand Rapids, Mich. "New Yankee" drill grinders.

Yale & Towne Mfg. Co., New York City. Hoists, chain blocks, trolleys, etc.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

SCHUCHARDT & SCHUTTE ENGRAVING MACHINE

Schuchardt & Schütte, Cedar and West Sts., New York City, are now building a machine for engraving trademarks, name-plates, letters, numbers, etc., on steel stamps, dies and other products. The machine operates on the pantograph principle; a pattern of the required design is slipped into a slot in the pattern table and strapped in place. At one end of the pantograph there is a guiding point which is brought into contact with the pattern and run over it; and the engraving tool is carried by a spindle at the opposite end of the pantograph. The movement of the guiding point over the pattern, causes the engraving tool to follow exactly the same course. Three of the arms on the pantograph are provided with scales by means of which the relation between the lengths of the arms can be adjusted to obtain any desired size for an engraved design, the limit of the machine being from a ratio of 1 to 1 between the size of the work and the pattern down to a ratio of 1 to 10 between the work and the pattern. Where only a few pieces are to be engraved, the design drawn on Bristol board can be used for a pattern.

In addition to having the engraving tool guided over the work by means of the pantograph, it is necessary to have the tool rotated. A brief consideration will suffice to show that the movement of the tool by means of the pantograph makes it necessary to provide a flexible system for supporting the driving pulleys. The way in which this is arranged by three sets of pivoted arms is very clearly shown in Fig. 2. One of the difficulties which has been experienced with en-

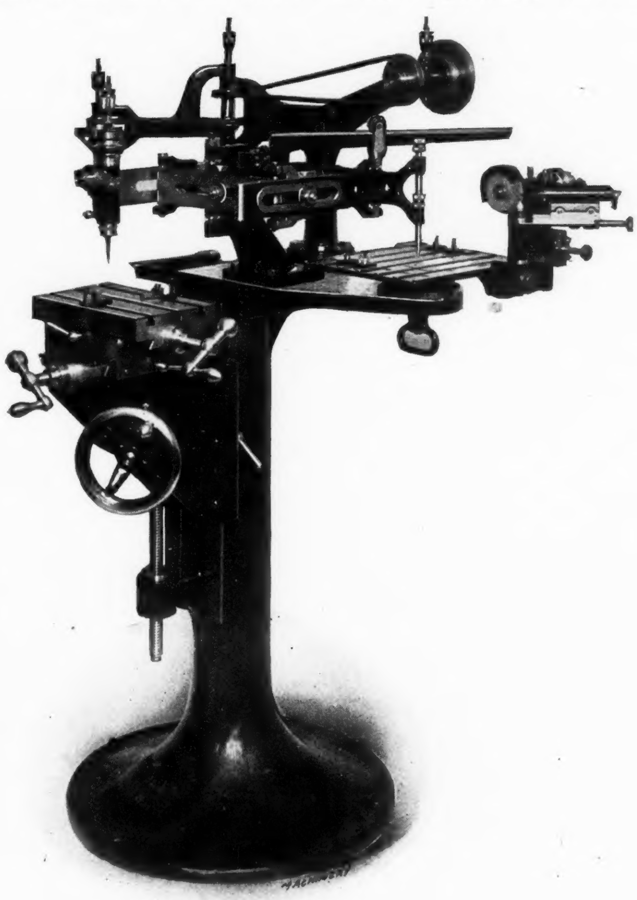


Fig. 1. Schuchardt & Schutte Engraving Machine

graving machines working on the pantograph principle, is that the bearings supporting the tool spindle become worn through the belt pull, thus causing a serious inaccuracy in the work produced by the machine. In the new Schuchardt & Schütte engraving machine, this difficulty has been overcome by employing the extended sleeve construction which has been successfully applied in various classes of machine design, for eliminating unnecessary strain on the bearings. This sleeve extends up from the main spindle housing, between the spindle and the driving pulley so that the belt pull is supported by the sleeve rather than the spindle bearing, and, in this way, unnecessary wear of the bearing is avoided.

In Fig. 1 a small grinding attachment is shown bolted to the pattern table. This attachment is used for grinding the

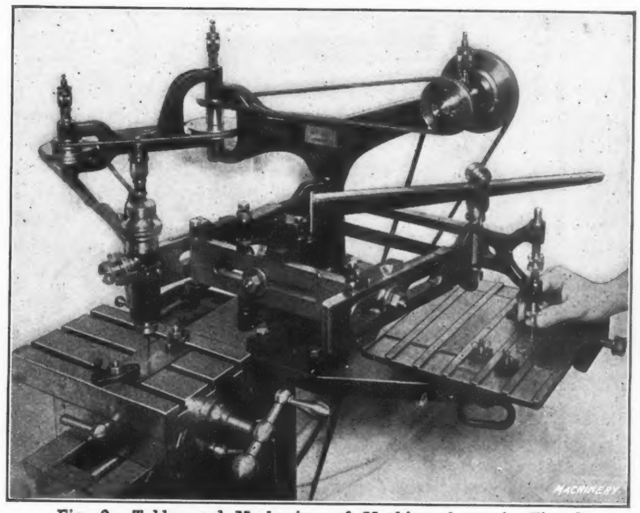


Fig. 2. Tables and Mechanism of Machine shown in Fig. 1

engraving tool. It will be seen that there is a two-step cone pulley at the right-hand side of the machine, which is not shown with a belt running over it. One of the steps on this pulley is connected to the source of power which drives the machine, and the other is used for carrying the belt which transmits power to the grinding attachment. One of the engraving tools is shown set up in the horizontal chuck, with its point in contact with the grinding wheel. In setting up this tool ready for grinding, the first step is to have it accurately centered. This is done by bringing the point of the tool into contact with an index point on the end of a pin, which is set up in the bed of the grinding attachment. The engraving tool is cylindrical in shape, and for about 1½ inch at its lower end a flat is ground which removes about one-half of the metal. The tool is not ground, however, by merely rotating it about its axis, with the tool in contact with the wheel. Experience has shown that the best results are obtained by having the ground surface of the tool of an elliptical section instead of circular, and this special form is obtained by controlling the motion of the tool when in contact with the grinding wheel, by means of a cam located at the far end of the tool-holder. The grinding attachment is bolted to a lug on the under side of the pattern table and may be quickly removed by simply loosening one bolt.

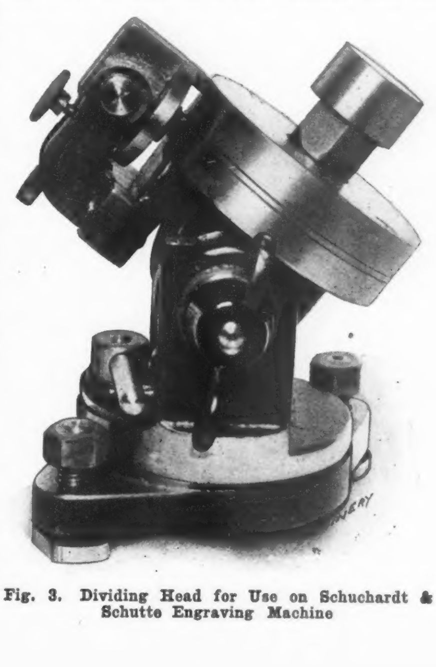


Fig. 3. Dividing Head for Use on Schuchardt & Schutte Engraving Machine

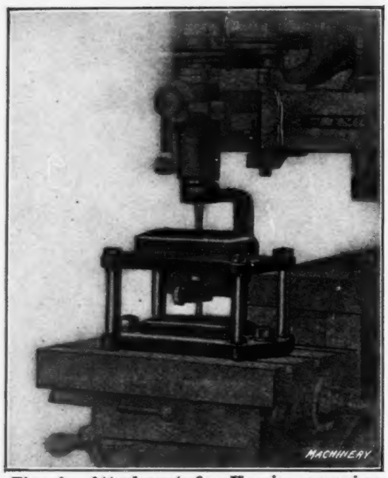


Fig. 4. Attachment for Use in engraving on Convex or Concave Surfaces

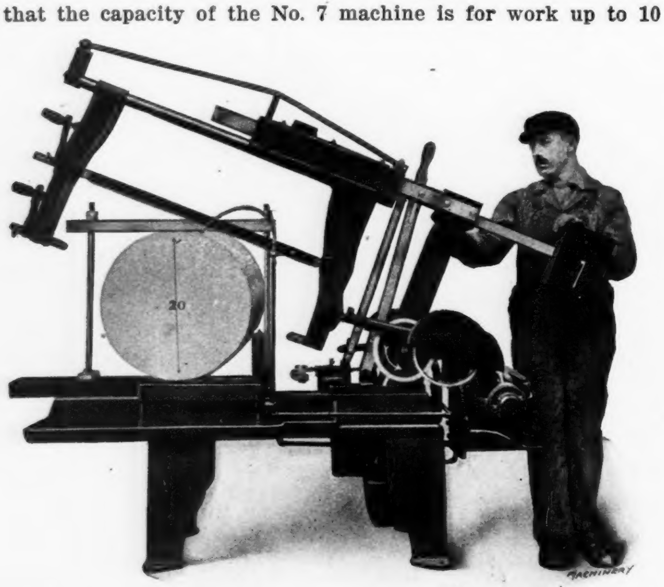
Fig. 3 shows an attachment for use on this machine, which provides for engraving on cylindrical or conical surfaces, or on flat dials on which it is required to engrave at equal intervals. This attachment consists essentially of an arbor on which the work can be mounted, and the provision of means for rotating this arbor through any required angle between successive engraving operations. For engraving on cylindrical or conical surfaces, it is obviously necessary to have the element of the surface on which the engraving is to be done held in a horizontal position. This is done by loosening the wing nut and then swinging the arbor down to the required angle. In most cases, where engraving is to be done on such surfaces, the pattern itself is flat and strapped to the pattern table in the usual way.

Another useful attachment for use on this machine is illustrated in Fig. 4. This attachment is for use in engraving on concave or convex surfaces. For work of this nature, it is necessary to have the engraving tool work to a constant depth, but the tool must also follow the contour of the work. This is done by having a master blank of the required form located on the lower support of the attachment. A guide point runs over this master blank and controls the movement of the engraving tool, which is in contact with the work carried on the upper support of the attachment.

The design of the machine has been carefully worked out to give it the necessary rigidity for withstanding hard service. When desired, three different styles of pattern letters and pattern numbers can be supplied with the machine. Many manufacturers, however, prefer to use some other style of patterns, and these can be made direct on the machine. Of course, the same statement applies to the production of patterns for trademarks, name-plates and similar designs. The operation of this engraving machine is so simple that it has been found that a boy or girl of average intelligence can be taught to use it and to do very satisfactory work.

ROBERTSON 20-INCH HACKSAW

In the May, 1914, number of MACHINERY, the No. 7 power hacksaw built by the W. Robertson Machine & Foundry Co., 32 Greenwood Place, Buffalo, N. Y., was illustrated and described. Those who read this description will remember that the capacity of the No. 7 machine is for work up to 10


Robertson Hacksaw for cutting Stock up to 20 Inches in Diameter

inches in diameter. Since that time, a machine of quite similar design has been brought out by this company, the change consisting of the application of a special saw frame which increases the capacity up to work 20 inches in diameter.

In order to cut work of the maximum size which comes within the range of this machine, without raising the frame to an extreme angle, the first ten inches of the cut is made by inserting a blade in the middle of the frame, as shown in the illustration. When the first half of the cut has been completed in this way, the blade is mounted at the bottom of the frame, after which the cut is completed.

BESLY DOUBLE-SPINDLE, MOTOR-DRIVEN GRINDER

A recent product of Charles H. Besly & Co., 120-B N. Clinton St., Chicago, Ill., is the double-spindle, motor-driven ring-wheel grinder, front and rear views of which are shown in the accompanying illustrations. This machine is equipped with 21-inch vitrified wheels and is driven by direct-connected motors. The double-spindle design brings the two grinding wheels into contact with the work so that two parallel surfaces can be ground simultaneously.

The motors are bolted onto sub-plates which are mounted on ways planed on the main bed casting and clamped in position, the arrangement being similar to that of the head- and tailstocks of a lathe. The left-hand head of the grinding machine is stationary while the right-hand head can be moved along the bed by means of a rack and pinion, and clamped to grind the work to any desired length or width within the capacity of the machine. The motors are rated

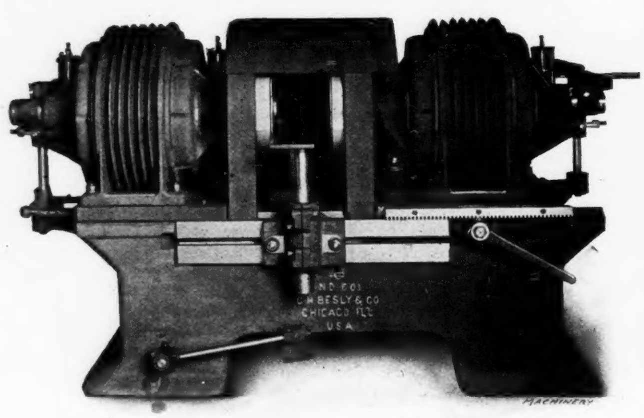


Fig. 1. Front View of Besly Double-spindle Motor-driven Ring-wheel Grinder

at 10 horsepower, run at 900 revolutions per minute, and are intended for operation on 60-cycle alternating-current circuits. When motors are provided for operation on 25-cycle circuits, the machine is equipped with ring wheels 24 inches in diameter, in order to get the required peripheral speed when running at 750 revolutions per minute. Each motor is controlled by a starting compensator with low voltage and overload release; these starting compensators are mounted on the back of the grinder. Grinding machines of this type are not built to operate on direct-current circuits.

The ring wheels are held in "Helmet" pressed steel, ring wheel chucks which are so constructed that the ring wheels may be adjusted to compensate for wear. The design has been worked out in such a way that this adjustment may be made without removing the chuck from the spindle of the grinder. To bring the grinding wheels into contact with the work, the rotor shaft or spindle of each motor has a longitudinal feed of 1 inch. This feed is actuated by a hand lever or foot treadle, the motion being transmitted through a pinion and rack on each of the outer bearing bushings. The spindles are geared together by a connecting-rod at the back of the machine, so that their motion toward and away from the work is simultaneous and uniform. Either spindle may be thrown out of gear and locked so that the opposite wheel may be moved toward the work by means of the hand lever or foot treadle. This causes the rotor of the motor to be displaced ½ inch from magnetic balance during

the grinding operation. Careful tests have shown that this displacement only reduces the motor efficiency from 1 to 2 per cent, while the maximum output remains approximately the same as when the motor is running in magnetic balance. The longitudinal movement of each sliding spindle is limited by an adjustable micrometer stop which is graduated to read to 0.001 inch, so that the work may be accurately ground to size and duplicate pieces produced at high efficiency.

The work-rest has a vertical adjustment and is supported from a slotted pad on the front of the bed casting. The regular equipment includes nine work-rests of varying widths from 7/16 to 5 15/16 inches. An automatically telescoping dust hood is provided, which is hinged at the back in order to provide access to the ring wheels for changing them when necessary. This hood has an air-tight connection at the back of the machine to provide for exhausting the grindings. It will be noticed that the motor rotors are mounted directly on the grinding spindles which are of hard machine steel and supported in inserted bearing bushings lined with bearing metal. The motors are equipped with special end castings to receive the inserted bearing bushings, and the end thrust on the spindles is taken by hardened and ground tool steel thrust collars. The end play of each spindle is controlled by an adjustable collar which is held in place by a lock-nut at the end of the spindle. Both bearing bushings slide with the spindle and completely encase it so that it is thoroughly reinforced when under load and adequately protected from damage by emery dust.

The geared hand lever on the sliding spindle affords a leverage of 36 to 1, so that the operator may force the machine to the limit of its driving power without undue effort. The lever is clamped to the pinion stud, which is a desirable feature of the grinder because the lever may be clamped to

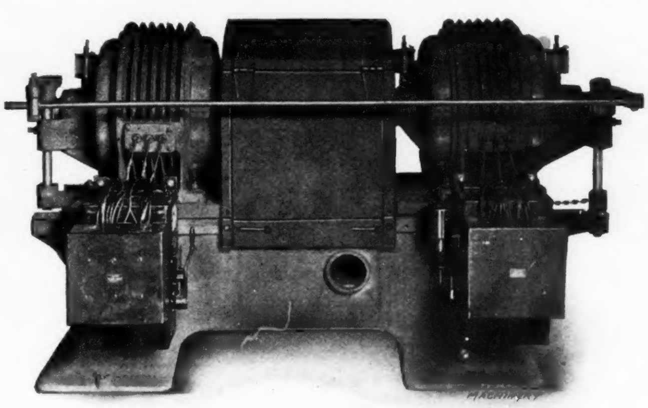


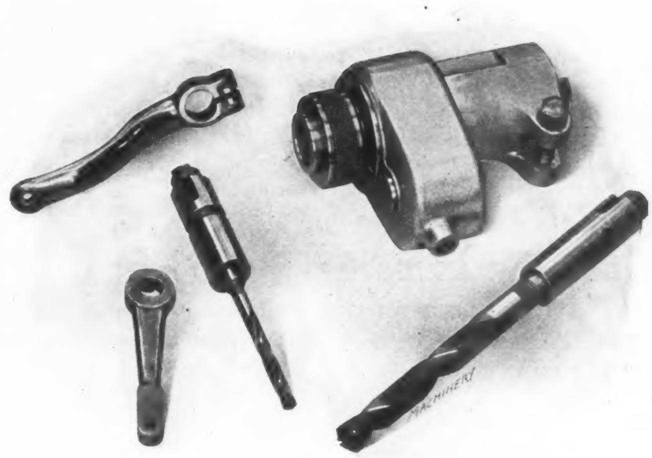
Fig. 2. Opposite Side of Machine shown in Fig. 1

this stud in the position which makes it most convenient for the workman. The principal dimensions of the machine are as follows: Diameter of spindles at inner bearings, 3 inches; diameter of spindles at outer bearings, 2½ inches; height of the machine to the center line of the spindles, 38 inches; combined length of four bearing bushings, 42 inches; maximum opening between ring wheels, 11 inches; floor space occupied by the bed casting, 28 by 72 inches; shipping weight of the machine, 6000 pounds.

DRILL SPEED REGULATOR

The Drill Speed Regulator Co., 516 Free Press Bldg., Detroit, Mich., is placing a device upon the market which provides for driving different sizes of drills at approximately the correct speed. In addition to the obvious advantage of securing the most suitable speed, the device is provided with a quick-change chuck so that different sizes of drills which are required may be inserted and removed with a very small loss of time. A different collet is provided for each different size of drill which is used, and this makes it impossible for the most inexperienced operator to use the wrong speed for a given size of drill. It is merely necessary for the operator to insert the drill in the chuck and it will be driven at the right speed.

The speed changes are accomplished by having the drivers



Device for obtaining Proper Speed for Different Sized Drills*

on each different collet located in a different position so that each one engages the proper gears in the head. This device also increases the power of the drill press, as large drills are driven through back-gears; and it can be used for tapping when applied to drill presses equipped with a reverse mechanism. The illustration shows the complete speed regulator and also two collets; one of these collets has a 5/16-inch taper shank drill in it and the shank of the collet is No. 1 Morse taper. The other collet carries a ¾-inch taper shank drill and its shank is No. 2 Morse taper. Two pieces are also shown in this illustration which are typical of the classes of work for which this speed regulator is particularly useful. These speed regulators are made to fit any drill press of standard design.

COCHRANE-BLY PORTABLE FILING MACHINE

In shops where large numbers of dies, gages, templets and similar parts are made, there is a lot of light filing to be done at different benches. For handling work of this kind the Cochrane-Bly Co., Rochester, N. Y., has been making a belt-driven bench filing machine. In order to adapt this machine for portable service, an aluminum motor base to support a ⅛-horsepower standard type, General Electric motor has been added. A motor for use on either alternating or direct current of 110 or 220 volts can be supplied and the entire equipment weighs only 75 pounds, so that it can be easily moved about from bench to bench. The motor is provided with a chord and plug for connection with an ordinary lamp socket.

One of these motor-driven equipments is shown in the accompanying illustration where it will be seen that the motor and filing machine are equipped with two-step cone pulleys. The slower speed is for use in filing and the higher speed is employed for lapping operations. As a general rule, the upper supporting arm is not required but this arm is found

Cochrane-Bly Motor-driven Filing Machine for Portable Service

particularly valuable in cases where lapping stones are used, and also for classes of work where rather coarse files are required. The file holder is for round file shanks, and a fixture is provided for babbitting ordinary file shanks to fit this file holder. The principal dimensions of the machine are as follows: Height from bench to top of table, 11 inches; diameter of table, 8 inches; face width of pulleys, 1¼ inch; speed of pulleys for filing, 500 R. P. M.; speed of pulleys for lapping, 600 R. P. M.; stroke, ¾ or 1½ inch.

SELLEW ADJUSTABLE DRILL HEAD

The accompanying illustrations show an adjustable spindle drill head which is a recent product of the Sellew Machine Tool Co., Pawtucket, R. I. Fig. 1 shows the head with the gear guards in place ready for use; and in Fig. 2, the guards are removed in order to show the gearing and construction of the head. Referring to this illustration, it will be seen that there is a ring or plate located at the top of the head, and an interchangeable sleeve for connecting the head to the quill of the drilling machine is bolted to this ring. Different sleeves may be bolted to the ring to provide for mounting the head on different drill presses. There is a circular T-slot on the under side of the ring which receives the T-bolts for clamping the intermediate gear sleeves which support the spindle heads after the spindles have been adjusted to the required positions.

The construction of the spindle heads—alternating short and long, as shown in the illustration—provides for making close adjustments with ease and rapidity. Each alternate spindle can also be brought directly under the clamping bolt of the spindle head nearest to it, either inside or outside of the intermediate circle. The gears supported by the intermediate spindle sleeves are driven by a central gear which has a taper shank entering the drilling machine spindle. All of the gearing and spindles are of heat-treated nickel steel, and the spindles have bronze-bushed bearings. Ball-thrust bearings, mounted outside of and below the spindle bearings, carry the end-thrust. Ample provision is made for lubricating each spindle bearing by means of individual grease chambers. The head shown in the illustrations is fitted with adjustable chucks, but sleeves for taper shank drills can be provided, if so desired. These heads are made in three sizes which range from a head having five spindles which can be distributed over a 1½-inch circle to twelve spindles which may be distributed over a 15-inch circle.

Fig. 1. Sellew Multiple Adjustable Spindle Drill Head

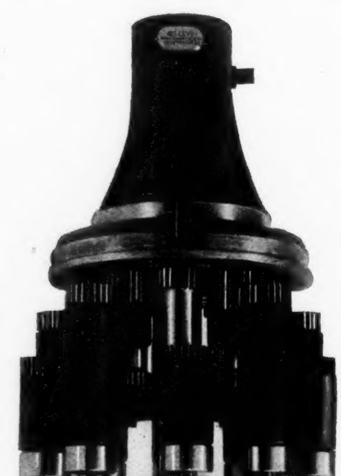
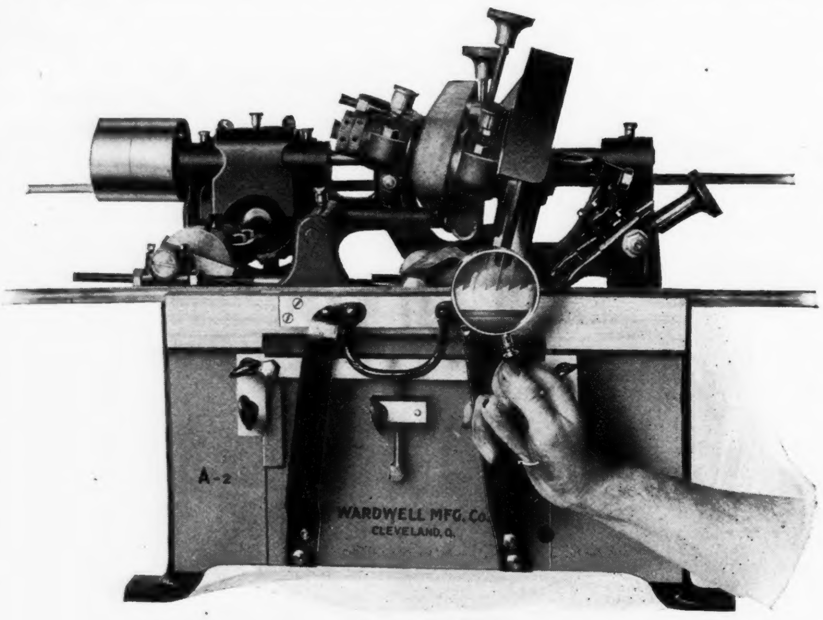


Fig. 2. Sellew Drill Head with Gear Guards removed

WARDWELL BAND-SAW SHARPENING MACHINE

The development of band-saw machines for cutting metal has been followed by a serious loss in certain plants, where it has been the practice to throw away the saws used for this purpose, after they have become dull. As such saws cost from $0.90 to $1.25 each, it will be readily understood that a serious "leak" results from this practice. In order to provide for resharpening metal cutting band-saws, the Wardwell Mfg. Co., Cleveland, Ohio, has recently designed and placed upon the market a grinding machine which is described in the following. By using this machine it is possible to resharpen saws at a cost of from 3 to 5 cents each.



Wardwell Grinding Machine for resharpening Metal-cutting Band-saws

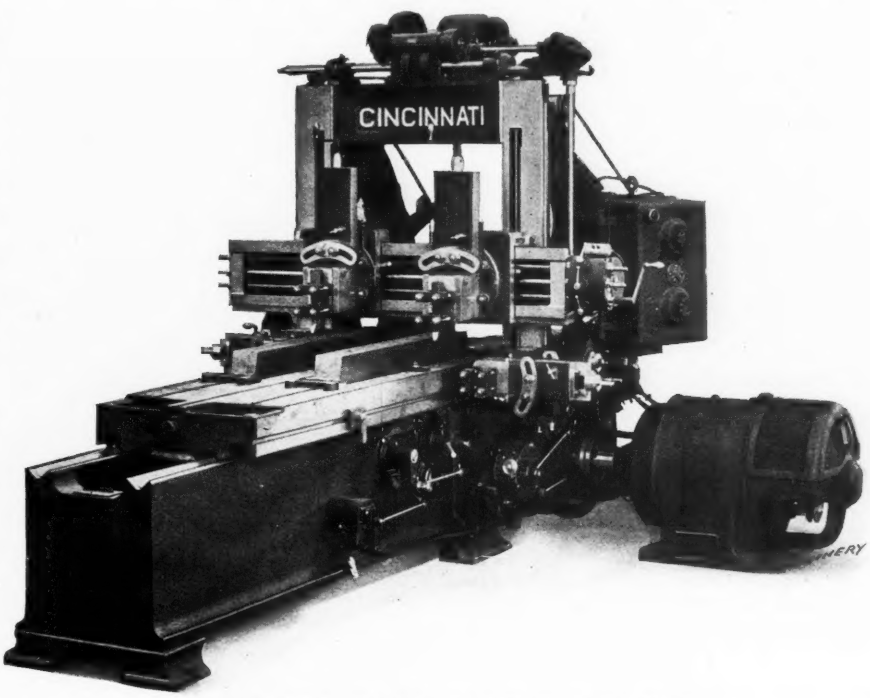
The operation of the machine is extremely simple. From the main driving shaft, which extends across the back of the machine, a belt transmits power to the shaft which drives the grinding wheel. This shaft is supported on a pivoted arm which swings over a segment, and the adjustment provided in this way enables the grinding wheel to follow the face of a tooth no matter what its angle may be. After the grinding wheel has reached the bottom of the tooth, a cam causes it to move up the back of the tooth, this cycle being repeated over and over for each tooth on the saw. Power is taken from the main shaft through a worm and worm-wheel, to a shaft at the left-hand side of the machine, on the end of which there is an eccentric which governs the feed of the band-saw. A secondary adjustment provides for making a more delicate regulation of the feed. An adjustment at the right-hand side of the machine permits the saw to be fed in such a way that the grinding wheel cuts exactly the required amount of metal from the face of each tooth. The proper combination of these adjustments enables the grinding wheel to be perfectly timed so that when the wheel has traveled all the way down the face of the tooth, the cam comes into action and raises the wheel as it travels up over the back of the tooth.

The operation of the machine is so

precise that saws having teeth as fine as twenty to the inch can be accurately resharpened. It will be understood from the preceding description that the machine is automatic in action, and after it has once been started it requires no further attention until the saw is completely sharpened. The saw is positively fed through the machine at the rate of from fifty to sixty teeth per minute. There is an adjustment on the front of the machine for raising the saw in the vise, thereby permitting a slightly heavier cut to be taken without changing the other adjustments. All of the adjustments are provided with locknuts, so that when they are once set and the nuts tightened, they cannot work loose. Band-saws resharpened on this machine are said to cut with practically the same efficiency as when they were new.

CINCINNATI HEAVY PATTERN PLANER

The Cincinnati Planer Co., Cincinnati, Ohio, is now building a 36 by 36 inch by 8 foot heavy pattern planer which is equipped with four heads and reversible motor drive. There are ten cutting speeds which cover a range of from 25 to 60 feet per minute and ten return speeds, the maximum return being 100 feet per minute. To adapt the machine for heavy classes of work, all the gears and also the rack under the table are of steel. A noteworthy feature of the design is the rapid power traverse to the heads, which relieves the operator and is the means of making a material increase in production. The mechanism is extremely simple, absolutely "fool proof" and ready for use at any time. The motor shown at the top of the arch delivers power through spur gears to the rail elevating device and thence to the horizontal rapid traverse shaft. This shaft carries a bevel gear meshing with a gear on the vertical rapid traverse shaft at the side of the housing. This shaft transmits power to a pair of spur gears located at the end of the rail.



Cincinnati 36 by 36-inch by 8-foot Heavy Pattern Planer

The regular feed is transmitted to the heads in the usual way from a friction on the end of the pinion shaft to the trigger or feed gears at the end of the rail, power being transmitted through a segment and rack. The feed and rapid power traverse gears on the rail screws and rod are free to revolve until clutched by a spool located between them. There is a neutral position in which neither of the gears is engaged. This arrangement makes it impossible to engage both the rapid power traverse and feed at the same time. Provision is also made to protect the mechanism against all accidents, making the entire control absolutely "fool proof." The three small handles at the end of the rail control the clutch spools while the handle just below them engages the rapid power traverse. Moving this handle to the right causes the heads to follow in the same direction, and *vice versa*. The rail and side heads are taper gibbed throughout and the heads on the rail are provided with micrometer adjustment. The housings are extended right to the bottom of the bed, to which they are securely bolted, doweled and locked. All gears are covered to prevent the operator from being injured.

SCHUCHARDT & SCHUTTE SCREW TESTING MICROSCOPE

The demand for a high degree of accuracy which has followed in the wake of interchangeable manufacture has led to the development of many ingenious methods for insuring the attainment of a high degree of precision. One of the latest of these is the Schuchardt & Schütte precision measuring and screw testing microscope which forms the subject of the present article. This instrument is intended for making absolutely accurate measurements of small objects, and it is particularly adapted for measuring and checking micrometer screws, dividing scales, standard gages, dies and a great variety of other parts where precision is a prime requisite. An idea of the accuracy of the instrument may be gained from the fact that it will give the length and pitch of a screw to within 0.00004 inch; the maximum and minimum diameters, and depth of the thread to within 0.0004 inch; and the angle of the thread to within 5 minutes. In making any or all of these measurements it is unnecessary to change the position of the screw after it has been set up.

The illustration shows a screw set up in the instrument where it will be seen that the object to be examined is held in a chuck *A*. In the field of the microscope there are cross hairs which are used as reference points. In measuring the pitch of the screw, the vertical cross hair is first brought exactly over the high point of the thread, after which the reading of the scale *D* and micrometer head *E* is taken. The screw *C* is then manipulated to move the object across the field of the microscope until the cross hair comes into contact with the next point on the thread, after which the reading of the scale *D* and micrometer head *E* is taken again. The difference represents the pitch of the thread. Similarly, in measuring the depth of the thread, a horizontal cross hair is first brought into contact with the top of the thread, after which the reading of the scale and vernier *G* is taken. The screw *F* then moves the work until the horizontal cross hair reaches the bottom of the thread, after which the reading is again noted, the difference being the depth of the thread.

The field of the microscope can be rotated to provide for measuring the angle between the lines or surfaces on the work. For making such measurements the field is rotated to bring one of the cross hairs into contact with one of the angular sides, after which the reading of the scale and vernier *K* is noted. The field is then rotated until the same cross hair comes into contact with the opposite angular side, after which a reading is again taken. The difference represents the included angle between the sides and the result is accurate within 5 minutes. The field is rotated by screw *H*.

The object under examination may be inclined to the optic axis of the instrument and the angle of inclination read on the scale and vernier *M*. As the object remains in the same plane as the axis of rotation, it is not thrown out of focus owing to the inclination of the instrument. In measuring the pitch of a screw it should be inclined the same number of degrees as the angle at which the thread crosses it. This angle can be approximated or else accurately measured by

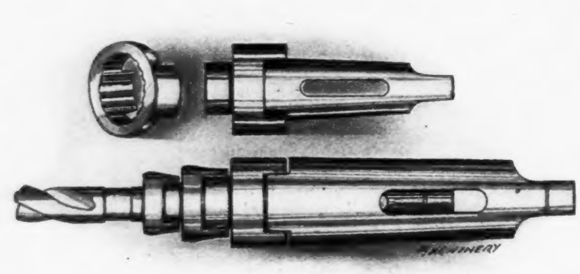
the scale provided for that purpose. The microscope is focused by means of the usual rack and pinion for coarse adjustment and a micrometer screw is provided for making fine adjustments. The dividing head *N* of the micrometer screw is used for obtaining the correct position for viewing the profile of the screw thread or other object which is being examined. This is accomplished by focusing the top of the thread on the cross hairs in the field of the microscope and then lowering the body by means of the fine adjustment an amount equal to the secant of the angle through which the screw is tilted multiplied by one-half the maximum diameter of the thread. The object under examination is illuminated by means of a mirror which will be seen near the base of the instrument. The iris diaphragm used in connection with the mirror can be quickly swung aside or brought back into position, according to the requirements of individual cases. For measuring large objects such as milling cutters, hobs, etc., a special bracket with adjustable centers is provided. This instrument is sold by Schuchardt & Schütte, Cedar & West Sts., New York City.

Schuchardt & Schutte Precision Measuring and Screw Testing Microscope

"DRIVE-EM-ALL" DRILL SOCKET

As its name implies, the "Drive-em-all" drill socket made by the Dazie Mfg. & Supply Co., Inc., 103 Park Ave., New York City, is applicable for driving all styles of taper shank drills and other taper shank tools. Referring to the illustration, it will be seen that there is a serrated ferrule which is driven over the shank of the drill. This ferrule constitutes one member of a clutch, the corresponding clutch member being formed by the end of the socket; and in this way a positive drive is secured. As the socket will drive drills either with or without a tang, one of its important advantages is for using up drills with broken tangs.

In using this socket, the first step is to press the ferrule



"Drive-Em-All" Drill Socket

down onto the shank of the drill. If the drill has a tang, the ferrule is placed in such a position that the tang enters the slot in the socket. The ferrule should be forced far enough onto the shank so that there is a small opening between the ferrule and the socket, the purpose being to provide for wear which may develop when the tool has been in use for some time. When a drill is worn out, the ferrule can be removed from its shank and used on another tool. These sockets and ferrules are made in twelve different styles for various combinations of inside and outside tapers.

TUCKER OIL HOLE COVERS

Four styles of oil hole covers which constitute a recent addition to the line of W. W. & C. F. Tucker, Hartford, Conn., are illustrated herewith. These are known as Styles D, E, F and G, and they are so marked in the illustrations in order to provide a ready means for reference. Fig. 1 shows each style of oil hole cover open ready for oil to be introduced into the port, while the covers are shown closed in Fig. 2, these illustrations making the design so clear that only a brief description will be necessary.

It will be seen that the Style D cover is threaded at the bottom in order to be screwed into the oil hole which is tapped to receive it, and that there is a slot for a screwdriver at the top of the cover. The port is normally closed by means of a sleeve which is held down through a compression spring. In order to open the cover to give access to the port, this sleeve is raised with the point of the oil can, which is then pushed into the port and the necessary amount of lubricant supplied. These covers were particularly designed to meet a demand for an oiling device provided with means for excluding dirt and grit from the bearing. They are particularly adapted for use in connection with spring hinge

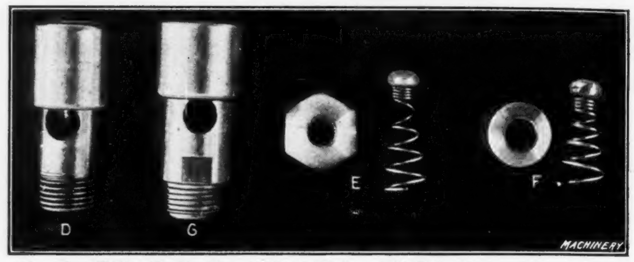


Fig. 1. Styles D, E, F and G of Tucker Oil Hole Covers shown Open

bolts and other parts of motor cars, and can be mounted in a horizontal or vertical position or at an angle. A little experience will enable the oiler to raise the sleeve over the port with the point of his oil can so that only one hand is required for the purpose. It will be seen that the Style G cover is quite similar to the Style D, except that a flat is provided on each side of the body to enable the wrench to be used in screwing the cover down into the tapped oil hole instead of having a slot to be engaged by a screwdriver.

It will be seen that the Styles E and F oil hole covers are the same in general respects, the point of difference being that the Style E is threaded at the bottom to be screwed into a tapped oil hole, while the Style F is tapered so that this cover is driven into the hole. The top of both covers is slightly rounded so that a clean wiping surface is provided,

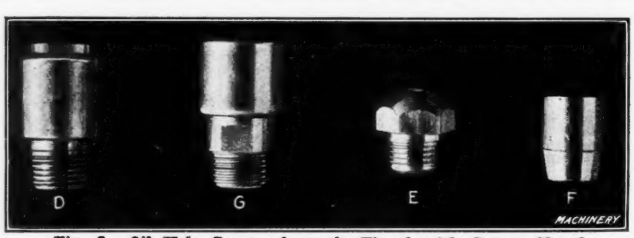


Fig. 2. Oil Hole Covers shown in Fig. 1 with Covers Closed

and there are no sharp corners to hold the dirt. It is claimed that the valve or ball check which closes the port of these covers is exceptionally small, thus providing a greater open space for the oil to enter. In the illustration Fig. 1, the spring and ball which keep the port closed is shown beside the cover.

SCHUCHARDT & SCHUTTE GAGE STANDARDS

For machining work where a very high degree of accuracy is required, the use of gage blocks as the ultimate standard to which all of the gages and measuring instruments used in the shop are referred has come to be recognized as one of the most satisfactory methods of securing the desired degree of precision. Schuchardt & Schütte, Cedar and West Sts., New York City, are now making gage standards of

this type in several different sets, one of which is shown in the accompanying illustration. The No. 9 set, which is the most complete, is intended for use in checking the accuracy of measuring tools such as standard gages, limit gages, micrometer calipers, etc. The blocks may be combined to give intervals of 0.0001 inch and the individual blocks are so accurate that any combination of four or five blocks will have a total error which does not exceed 0.00004 inch. The No. 8 set of gage blocks is similar to the No. 9 except that there are not as many blocks in this set, and it is only capable of combinations for intervals of 0.001 inch. For shops where the English system of fractions is used on work requiring great accuracy, three sets of gage blocks known as Nos. 6, 7 and 7A are provided. The blocks in these sets are graded in 1/16-inch steps, 1/32-inch steps and 1/64-inch steps, respectively. While there is a smaller number of blocks in these sets, they are of the same accuracy as the more complete sets previously referred to.

By referring to the illustration, it will be seen that these gage blocks are prismatic in shape and the distance is marked between the parallel surfaces of each block. It is a well-known fact that hardened steel products are subject to variations in their shape and dimensions for some time after conducting the heat-treatment. This difficulty is eliminated in the Schuchardt & Schütte gage standards through the use

No. 8 Set of Schuchardt & Schutte Gage Standards

of a special tempering process which relieves the excessive internal strains without softening the metal. The gages are non-magnetic when they leave the factory and particular care should be exercised to prevent them from becoming magnetized. If this precaution is not observed, very fine particles of metal will be picked up by the gages, and although these particles may be too small to be visible, they will introduce appreciable errors when several gage blocks are used in combination. In using the blocks the surfaces are first wiped with a piece of chamois leather to remove any grease or dirt, after which the gages which are to be in contact are placed edge to edge and the contacting surfaces slid across one another with the application of a moderate pressure. The surfaces are so smoothly finished that molecular attraction causes the blocks to be held together. As the size is stamped on each block, all the knowledge a workman requires in using these gage standards is the ability to make a simple arithmetical addition in order to determine when he has obtained the required dimension. This is done by adding the size of each gage block as it is combined with the blocks already selected, until the required combination is obtained.

AUTOMATIC DRILL CHUCK

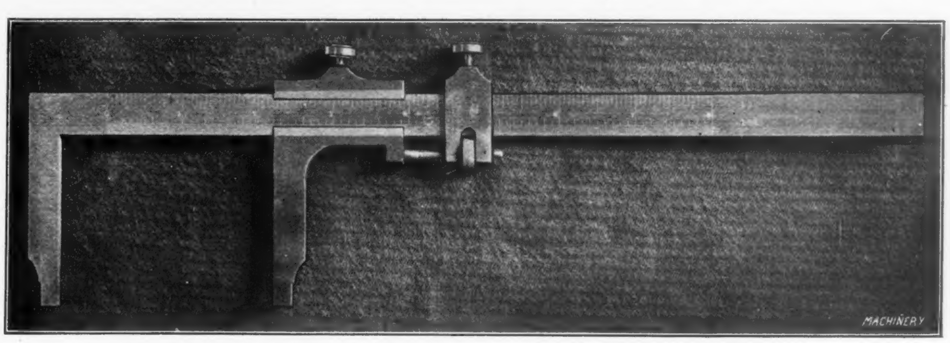
The "Quictite" drill chuck, which forms the subject of this article, is the latest product of the Automatic Drill Chuck Corporation, Majestic Bldg., Detroit, Mich. The most important feature of this chuck is the rapidity with which drills can be inserted or removed. For this purpose it is merely necessary for the operator to grasp the knurled collar and hold it back against the rotation of the drill-press spindle. This opens the jaws of the chuck so that the drill may be pushed up until it comes into contact with a hardened thrust plug. The knurled collar is then released and the jaws spring forward and take a firm grip on the shank of the drill. These chucks are made in three different sizes. The illustration shows the No. 6 size which has a capacity for drills from No. 40 up to ⅜ inch; this chuck can be opened by hand when the drill-press spindle is running at speeds up to 4000 R. P. M. This type is also made in a No. 8 size which has a capacity for drills ranging from 3/16 to 1/2 inch in diameter, and in a No. 5 size having a capacity for drills from ½ to 1 inch in diameter. All sizes of drills operate in the same way.

The "Quictite" Automatic Drill Chuck

The two most important features of the rotary cam type of jaws used in these chucks are the powerful gripping action which is secured and the smooth contact surface which is provided. The driving power provided by the chuck jaws increases in direct proportion to the resistance offered by the cut, and there is no tendency for the jaws to damage the shank of the drill. There are three jaws, each of which has a triple set of grips, so that a total of nine contact points engage the shank of the drill. The action of the jaws is self-centering, no matter what the size of the drill, so that all drills are always accurately centered in the chuck. Particular attention has been paid to the construction of the chuck along lines which provide ample strength and durability.

SMITH OPEN-FACE CALIPER

A vernier caliper of the beam or sliding type, which is a recent product of E. G. Smith, Columbia, Pa., is illustrated herewith. This tool differs from the general style of Columbia sliding calipers in that it has a so-called "open face" which is a great convenience in reading the measurement. At present this tool is only made in the 8-inch size, with the lower scale graduated to fiftieths and provided with a vernier to read to 0.001 inch; and with the upper scale graduated in sixteenths, with a vernier to read to 1/128 inch. The construction and shape of the jaws provides as much strength as in other styles of Columbia calipers. The jaws are hardened and accurately ground.



Smith Open-face Caliper with Scales reading to 0.001 Inch and to 1/128 Inch

GARRIGUS PRECISION GRINDER

The C. G. Garrigus Machine Co., Bristol, Conn., is now building a 12-inch rotary surface grinder which is particularly adapted for precision work. The design of this machine is marked by its simplicity and durability, and as the grinding operation is continuous, the rate of production is very satisfactory. The range is from very small pieces up to anything that will come within a 12-inch circle, and pieces can be finished within 0.0004 inch of the required dimension.

C. G. Garrigus 12-inch Rotary Surface Grinding Machine

The head is supported on a vertical oscillating column which is attached to the feed-shaft and actuated by a ratchet and pawl. Each tooth of the ratchet lowers the grinding head 0.000125 inch. The magnetic chuck is mounted on a spindle that is operated by a cone clutch pulley and connected by gearing to the cam which operates the wheel column. The stroke of the oscillating wheel is regulated by the adjusting cam roll. The movement of the head and rotation of the chuck are controlled by the action of a lever at the side of the machine.

When this grinding machine is equipped for grinding cast-iron parts, such as piston rings, a special wheel cover with an opening to which a flexible tubing is connected, is mounted on the machine. A different style of pan is also used which makes the machine more accessible for the operator when grinding single pieces. For wet grinding, a tank connected with a pump affords a continuous supply of water to the work held on the chuck. The chuck has two speeds and is operated by hardened steel gears. The principal dimensions of the machine are as follows: Size of grinding wheel, 12 by ¾ inch; greatest distance from center of wheel to top of chuck, 12 inches; vertical adjustment of head, 8 inches; diameter of magnetic chuck, 12 inches; and weight of machine, 1400 pounds.

STANDARD UNIVERSAL ELECTRIC GRINDER

The Standard Electric Tool Co., Cincinnati, Ohio, has placed a new grinder on the market which is intended for such work as surfacing rough castings and also for performing buffing operations. This tool is provided with a universal motor which operates on either alternating or direct current with equal efficiency. It is especially adapted for use on low-frequency circuits of 25, 30 or 40 cycles. The motor is form wound and impregnated with "Bakelite," which effectually prevents short circuits, grounds and other troubles incident to high-speed operation.

Standard Grinder equipped with a Universal Motor

The motor is designed to run at 6000 revolutions per minute, and the armature spindle is extended and has a 4-inch emery wheel mounted directly upon it. Imported ball bearings are employed throughout the tool. The motor has a capacity for ½ horsepower and is said to be exceptionally durable. The efficiency is unusually high when operating on alternating current, owing to the high speed at which it is required to operate. The grinder is equipped with a spring for suspending it from the ceiling and it can be used in connection with a traveler and counterbalance. The motor may be attached to either a lamp socket or a power circuit.

AURORA 20-INCH DRILLS

Two improved 20-inch drills which are recent products of the Aurora Tool Works, Aurora, Ind., are illustrated in Figs. 1 and 2. These machines are of exceptionally heavy construction, with the column and base well ribbed and the head fitted on the column with a tongue and groove joint, and securely bolted by three ½-inch cap-screws. Power is transmitted to the spindle by four-step cone pulleys which carry a 2½-inch belt. The tight and loose pulleys are 9 inches in

Fig. 1. Aurora 20-inch Drill equipped with Wheel and Lever Feed

diameter and carry a 3-inch belt; these pulleys run at from 550 to 600 revolutions per minute. Ample power is provided for driving a 1½-inch drill to the limit of its capacity.

The table rests on a large flat bearing in addition to being supported by the usual pivot bearing, this construction insuring perfect alignment even when holes are being drilled at points near the edge of the table. The spindle is fitted with a ball-thrust bearing and has a travel of 8 inches. On the plain wheel and lever feed drill, shown in Fig. 1, the worm is engaged or disengaged by means of an eccentric bushing. The feed lever is operated by a ratchet and pawl which automatically disengages when in the vertical position. On the drill equipped with power feed, which is illustrated in Fig. 2, the feed gears are of hardened steel and run in an oil-tight case. Three changes of feed can be instantly obtained without requiring the machine to be stopped. Each change of feed is clearly marked so that there is no excuse

for the operator making a mistake. The spindle sleeve is graduated and equipped with an automatic stop collar which disengages the feed when the tool has reached any required depth. The table and also the base of the machine are fur-

Fig. 2. Aurora 20-inch Drill equipped with Power Feed

nished with T-slots. The weight of the plain wheel and lever feed drill is 735 pounds, while the drill equipped with power feed weighs 900 pounds.

HARRINGTON MULTIPLE-SPINDLE DRILLS

Edwin Harrington, Son & Co., Inc., Philadelphia, Pa., are now building a line of multiple-spindle drill presses which includes machines with circular heads ranging from 15 to 36 inches in diameter; and with rectangular heads ranging from a spindle area of 15 by 24 inches up to a spindle area of 20 by 40 inches. The number of spindles varies from 12 to 32, depending on the size of the head and the size of the drills which are to be used, the design of each machine having been worked out in such a way that it may be equipped with any size of spindle unit. The smaller machines are built to provide for movement of the head on the column by hand, but in the three larger sizes, the movement of the head is controlled exclusively by a power-driven screw. The illustrations show three different sizes of these machines from which an idea of the general design may be obtained.

No. 51-A and 51-B Machines

These are the smallest sizes of the Harrington multiple-spindle drills and the design of the two machines is essentially the same. They are made with two sizes of heads, each of which has a different spindle area and maximum number of spindles. The maximum area covered by the spindles of the head of the No. 51-A machine is over a circle 15 inches in diameter, and the machine has a capacity for driving twelve ½-inch drills. The No. 51-B machine is equipped with a head whose maximum spindle area is a 20-inch circle, and this head will drive sixteen ½-inch drills. Provision is made in the gear chest of each size head for the maximum number of spindle pinions so that the machine purchased with less than the full complement of spindles can be brought up to a full equipment at any time. Both machines have sufficient power for driving the rated number of drills in cast iron, at a peripheral speed of 65 feet per minute and a feed of 0.010 inch per revolution.

The head frame is cast in one piece with the saddle and is provided with heavy gibs and a long bearing on the column. A full counterbalance weight inside the column is connected to the head by two chains. There are two T-slots in the lower flange of the head for clamping the cast steel radius bars in which the bronze spindle sleeves are carried. The adjusting screw is arranged so that the spindle sleeves can be regulated up and down for different lengths of drills without moving the positions of the radius arms; the spindles have a long bearing in bronze sleeves and are provided with steel and bronze thrust washers. A telescopic shaft with universal joints at each end connects each spindle and its pinion. The drive is through a quarter-turn belt from a pulley mounted on the base of the machine to a pulley carried by a bracket at the top of the column; this drives the splined vertical shaft. A pinion on the lower end of this shaft transmits power to the upper gear of a pair of spur gears; and the lower gear of this pair drives the spindle pinions. All gears are made of heat-treated alloy steel except in cases where one gear of a pair is steel and the other bronze. All the gears have cut teeth. In belt-driven machines, a four-step cone pulley is driven from an overhead

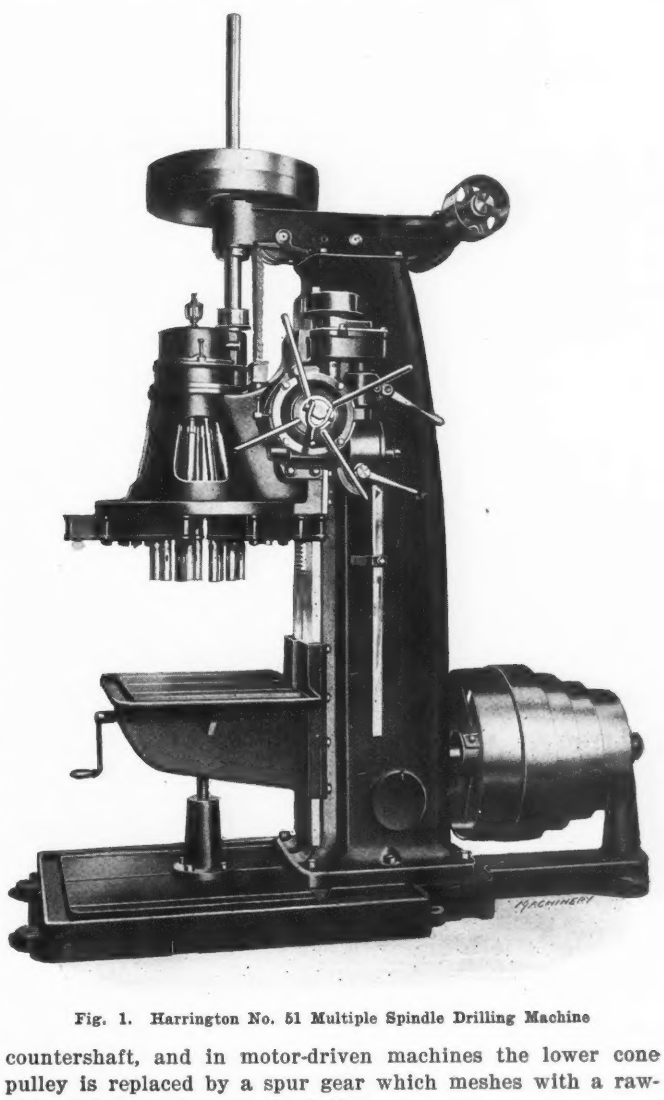


Fig. 1. Harrington No. 51 Multiple Spindle Drilling Machine

countershaft, and in motor-driven machines the lower cone pulley is replaced by a spur gear which meshes with a raw-hide pinion on the motor spindle.

Power for the feed is taken by belt from the vertical shaft and thence through spur gears. The motion is then transmitted through bevel gears to a horizontal worm and worm-wheel. The planetary train of spur gears between the worm-wheel and rack pinion reduces the strain on the worm-wheel teeth. Both hand and automatic trip are provided on the worm in addition to a saw-tooth disengaging clutch. The frame of the machine is exceptionally massive, the base being

heavily ribbed and provided with T-slots, an oil channel, and a settling tank. An extension is bolted to the rear of the base and the cone pulley or motor is mounted on this extension. The table has a long bearing on the column and an elevating screw under the center of the drilling area. If desired, three T-slots can be planed in the table. In addition to the dimensions already given, the following figures give an idea of the capacity of both the 51-A and 51-B machines, to both of which these dimensions apply. Shortest distance between spindles, $1\frac{3}{8}$ inch; vertical adjustment of each individual spindle, $1\frac{1}{4}$ inch; vertical traverse of head, 24 inches; vertical movement of table, 15 inches; floor space occupied, 7 feet 6 inches by 3 feet 2 inches; weight of No. 51-A machine, 5000 pounds, and weight of No. 51-B machine, 5400 pounds.

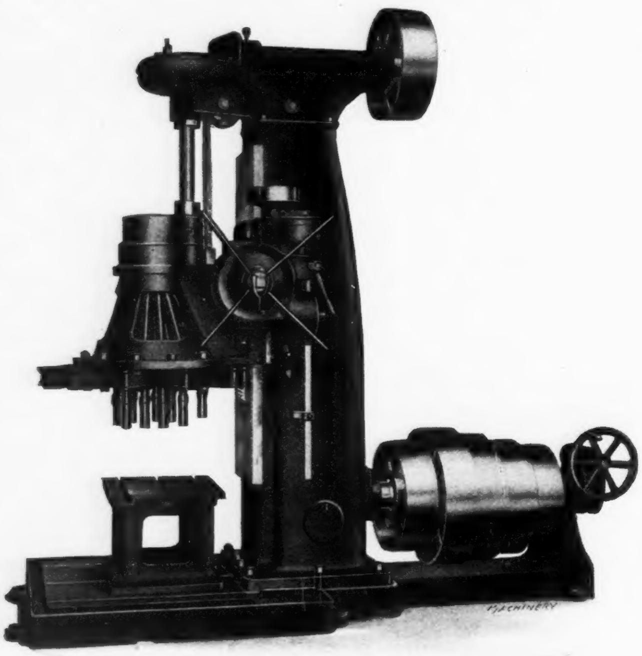


Fig. 2. Harrington No. 62 Multiple Spindle Drilling Machine

No. 62-A and 63-A Machines

These machines are of the same design except for the heads, which are of different sizes. The maximum area covered by the spindles of the head of the No. 62-A machine is a circle 20 inches in diameter, and this head has a capacity for driving twelve 1-inch drills. The head of the No. 63-A machine has a capacity for driving sixteen 1-inch drills and the maximum area over which the spindles can be distributed is a circle 25 inches in diameter. They have a powerful drive and easily operated rack feed. Provision is made for the full rated number of spindle pinions so that if purchased with less than the full complement of spindles, the remainder can be added at any time. All spindle dimensions refer to regular equipment of 1 inch capacity. Lighter spindle units for smaller drills can be used or the machine can be equipped with a smaller number of spindles of greater capacity than 1 inch, depending on the size. The driving power is sufficient to handle the rated number of drills in cast iron at a peripheral speed of 65 feet per minute.

The head is a solid casting rigidly braced to prevent springing and is fully counterbalanced, being connected by two chains. The radius bars are cast steel, clamped to the head by bolts through the flange. Each spindle runs in a bronze bushing, is driven by a heat-treated pinion, two hardened universal joints and a telescoping shaft, and has ball thrust bearings. Quick vertical adjustment for different drill lengths is made in any layout without moving the radius arms. The drive is by belt and bevel gears to the head, with a compact train of spur gears driving the spindles. The top shaft is mounted on roller bearings and the provision for lubrication is complete. Belt driven machines, with 7-inch or wider belts, are provided with an eccentric sleeve within the lower cone for decreasing the center distance when shifting the belt. In motor driven machines, a variable-speed motor drives directly to the upper pulley. Belt drive can be provided through a change gear box when required.

The feed is driven by belt from the vertical shaft, and there are three geared changes. A strong planetary train of spur gears on the rack pinion shaft reduces the strain on the worm gear teeth. The worm has both hand and automatic trip, besides a quick operating clutch for rapid hand movement of the head. The frame of this machine is very heavy. The base is heavily ribbed and provided with T-slots, oil gutter, and settling tank. An extension is bolted to the rear of the base for the cone pulley bracket or the motor as required. The table is of the open box type with large planed top surface and has three T-slots. An oil pump with distributing piping can be provided, and is driven by belt from the cone shaft. The principal dimensions of these machines are as follows: Minimum distance between spindles, $2\frac{1}{4}$ inches; vertical adjustment of individual spindles, $1\frac{3}{8}$ inch; vertical traverse of head, 34 inches; area of table, 24 by 24 inches for the No. 62-A machine, and 28 by 28 inches for the No. 63-A machine; weight of the No. 62-A machine, 8200 pounds, and weight of the No. 63-A machine, 8800 pounds.

No. 71-A, 72-A and 72-B Machines

These machines are all of the same type but vary in the size of frame and drilling area. Movement of the head in both directions is exclusively by power, the return stroke being automatically controlled. The drive is very simple but extremely powerful, and all of the feed and quick return control mechanism is carried in the bracket on top of the column. Provision is made in the gear chest of each for the maximum number of spindle pinions so that a machine purchased with less than the full complement of spindles can be brought to full equipment at any time. All machines have sufficient power to handle the rated number of drills in cast iron at a peripheral drill speed of 65 feet per minute and a feed of 0.010 inch per revolution. The head frame is cast in one piece with the saddle and has heavy gibs and a long bearing on the column. A counterbalance weight inside the column, connected to the head by two chains, relieves the pressure on the feed-screw. Bolts through the head flange and the slots of the radius bars hold them in position. These radius bars are steel castings, in the inner end of which is a bored hole, carrying the bronze spindle sleeve.

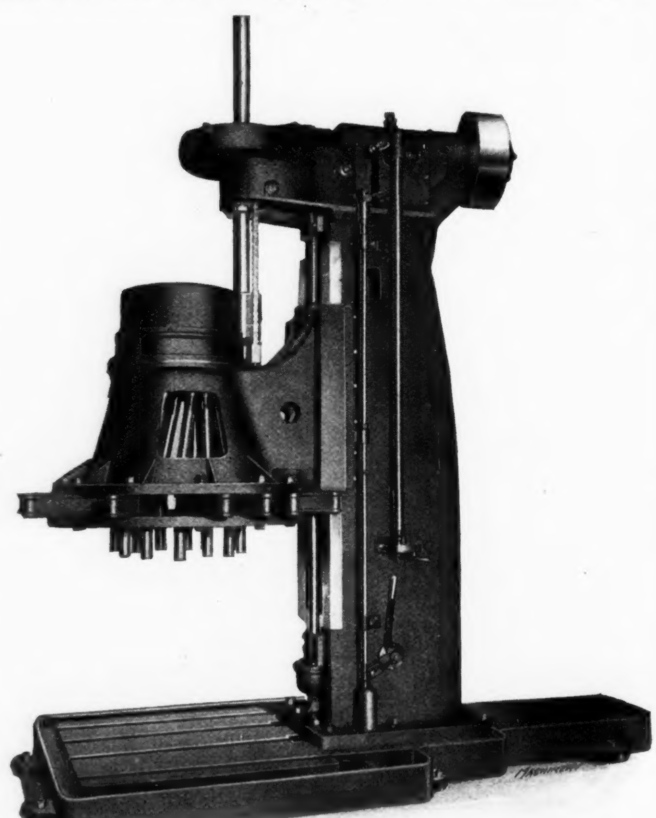


Fig. 3. Harrington No. 72 Multiple Spindle Drilling Machine

The adjusting screw is arranged so that this sleeve can be regulated up and down for different lengths of drills without moving the position of the radius arms. The spindles have a long bearing in the bronze sleeves and are provided with ball thrust bearings. A telescopic shaft, with universal joints at each end, connects each spindle and its pinion.

The drive is by vertical belt to the pulley on the top bracket, which is provided with a roller bearing and mounted on an extended sleeve so that the belt strain does not come on the driven shaft. A pair of bevel gears transmits the power to the vertical shaft which carries a pinion on its lower end meshing with the upper of a pair of spur gears in the top of the gear chest, the lower gear, in turn, driving the spindle pinions. All pinions are made of heat-treated alloy steel. All have accurately cut teeth and bearings at both ends of their shafts, with ample provision for constant lubrication. The type of drive recommended is from a variable speed motor on the rear extension of the base, by belt to the pulley overhead. Regular belt drive from an overhead countershaft can be provided, in which the lower cone is mounted on an eccentric shaft to slacken the belt when shifting. For belt drive without the use of a countershaft, or for constant speed motor drive, a change speed gear box is placed on the rear base extension. Both the feed and return of the head are obtained from a large screw in the face of the column and a unit gear box in the top bracket. The screw is in tension and has a ball thrust bearing at the bottom. Three changes of feed by positive gearing are provided, and quick movement of the head in either direction is obtainable through a friction clutch. The clutches are so arranged that when the drills have reached full depth, the head automatically returns to the top of the stroke ready to be started on the next drilling operation. The frames of these machines are very heavy and the base is heavily ribbed and provided with T-slots, oil gutter and settling tank. The table is of the open box type with large planed top surface having three T-slots and gutter. An oil pump with distributing piping can be located on the rear of the column, and is driven by belt from the shaft below.

Fig. 1. Improved Type of "Old Man" or Drilling Post made by Lutz-Webster Engineering Co.

The principal dimensions of the No. 71-A machine are as follows: Capacity, for drilling sixteen 1¼-inch holes; maximum area covered by spindles, a circle 25 inches in diameter; shortest distance between spindles, 2½ inches; vertical adjustment of individual spindles, 1½ inch; vertical traverse of head, 31 inches; weight, 22,000 pounds. The dimensions of the 72-A machine are: capacity, for drilling twenty 1¼-inch holes; maximum area covered by spindle centers, a circle 32 inches in diameter; shortest distance between spindles, 2½ inches; vertical adjustment of individual spindles, 1½ inch; vertical traverse of head, 40 inches, and weight of machine, 28,000 pounds. The dimensions of the No. 72-B machine are: capacity, for drilling twenty 1½-inch holes; maximum area covered by spindle centers, a circle 36 inches in diameter; shortest distance between spindles, 2½ inches; vertical adjustment of individual spindles, 1½ inch; vertical traverse of head, 40 inches; and weight of machine, 29,000 pounds.

LUTZ-WEBSTER "OLD MAN"

The drilling post or "old man," as it is commonly called in the shop, has been successfully used for many years in certain classes of drilling which cannot be handled on a drill press. Various forms of these tools have been made by different manufacturers, each of which has certain points of merit. The Lutz-Webster Engineering Co., Inc., 31st St. and Gray's Ferry Road, Philadelphia, Pa., has recently added to its line the equipment which forms the subject of the present article. This tool, used in connection with the Lutz compression wrench, makes a particularly serviceable outfit. It will be seen that two arms are shown, one of these being a plain arm while the other is a swivel arm, which provides for drilling holes at an angle. A detail of the swivel arm is shown in Fig. 2, from which the construction will be readily understood.

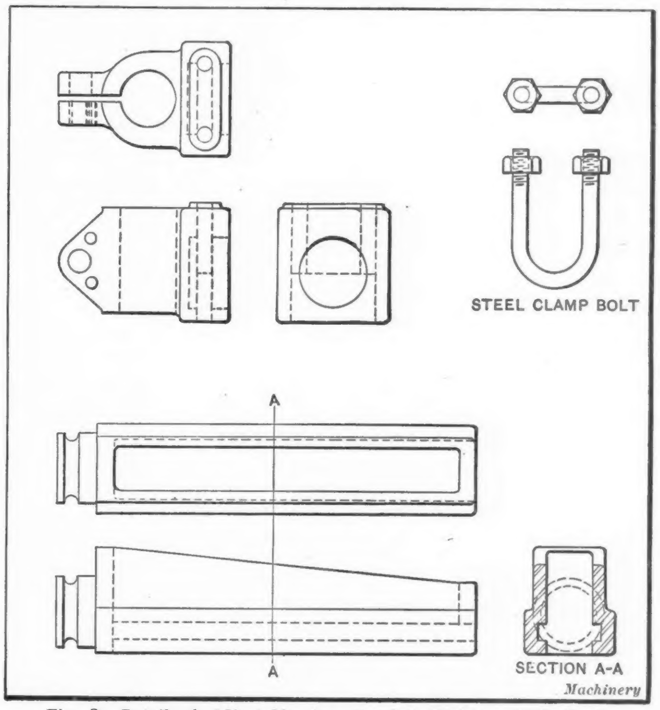
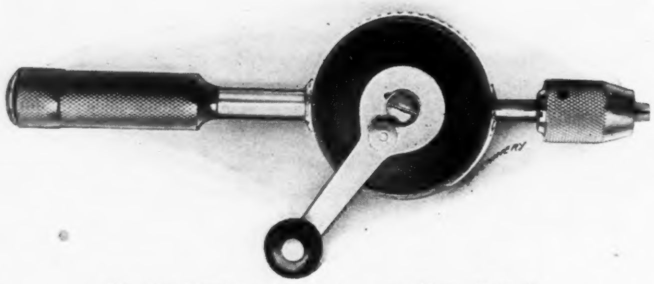


Fig. 2. Detail of Adjustable Arm for Lutz-Webster "Old Man"

The features of this improved style of "old man" may be briefly outlined as follows: The ratchet is a single piece, and even a straight shank drill may be used in place of the ratchet, where the Lutz compression wrench is used to drive the drill. Under such conditions, the wrench affords the necessary grip for turning through part of a revolution, and it may then be released and moved back to secure a fresh grip ready for the next forward movement. In addition to the usual feed arrangement, an auxiliary feed movement can be obtained by means of a pin fitting in the hole in the supporting screw which is turned by means of this pin. These drilling posts are made in 16-, 20-, and 26-inch sizes and can be made entirely of steel or of malleable iron.

MILLERS FALLS HAND DRILL

One of the recent products of the Millers Falls Co., Millers Falls, Mass., is a No. 353 hand drill which is made entirely of metal with the exception of the enameled wood crank handle. The knurled handle at the top of the drill is provided with a screw cap which may be removed to give access to the socket in which extra drills can be carried. It will be seen that there are two pinions engaging the driving gear, the purpose of this double pinion arrangement being to support the gear on both sides, thus relieving the bearing from

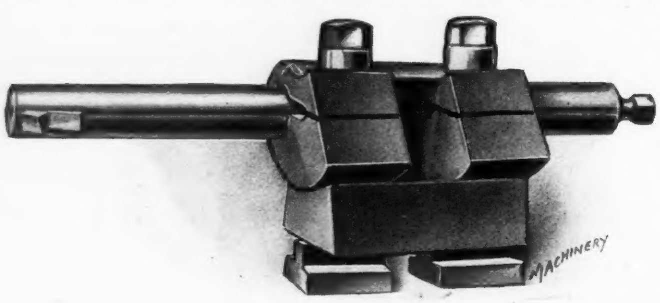


No. 353 Hand Drill made by the Millers Falls Co.

undue strain. The small knurled knob on the crank controls a ratchet which may be set to work either right- or left-hand, or to provide positive drive in both directions. The spring pawl connected to the knurled knob engages square holes in the driving gear. The pawl is tapered on one side and may be set so that the taper engages the holes to run back either right- or left-hand; and by setting the pawl edgewise with the holes, positive drive in both directions is secured. This ratchet mechanism is particularly convenient for use in cramped places. The capacity of the three-jawed chuck is for drills up to 3/16 inch in diameter.

RED-E BORING-BAR HOLDER

A recent addition to the line of tool-holders manufactured by the Ready Tool Co., 654 Main St., Bridgeport, Conn., consists of a boring-bar holder for supporting bars of the larger sizes. Reference to the illustration will make the method of using this tool clear without requiring an extensive description. It will be seen that the bar is mounted on the lathe by



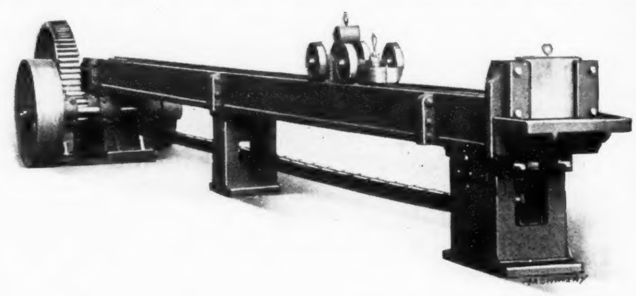
Ready Tool Co.'s Heavy Boring-bar Holder

first removing the toolpost and then inserting the T-bolts which secure the holder, in the T-slots in the carriage. Tightening up two nuts on the end of these bolts not only clamps the holder in place but also serves to secure the boring-bar in the holder. By rocking the upper part of the holder on the base, it is possible to adjust the bar for various heights that are required in different makes of lathes.

WATERBURY-FARREL CHAIN DRAW-BENCHES

For use in the manufacture of tubing, solid bars and similar products, the Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn., has brought out a line of chain draw-benches which supersedes preceding machines for the purpose, built by this company. The new machines are built in three sizes having pulling capacities of 10,000, 20,000 and 30,000 pounds on the chain. Several noteworthy improvements have been made in their construction. The chain drive is of the "two-in-one" type, having drop-forged center links, and the outer links are made of bar stock; this gives exceptionally good wearing properties, a feature which is accentuated by the fact that there is a large wearing surface between the chain and the sprocket. The hook and chain are so designed that there is less danger of accidents resulting from the refusal of the hook and chain to disengage at the end of the drawing stroke, than was the case in some of the older type machines. The compact and self-contained drive is arranged with an outboard bearing on the sprocket shaft which maintains the alignment of the gears while setting up or erecting the machine. This makes the labor and expense of manufacture, installment and up-keep less than it would otherwise be. The main pinion is also mounted between bearings on the shaft instead of being overhung, and this is a feature which gives additional rigidity. The improved type of wheel tongs is used which has been applied on chain benches built by the Waterbury-Farrel Foundry & Machine Co. during the past three years. These tongs relieve the operator of a fatiguing part of the work and they are returned more quickly than the sliding type of tongs, so that an increase in output is effected through their use.

These draw-benches are adapted for motor drive. The ratio of the gearing and the pulley sizes is so worked out that an ordinary commercial motor can be belted to the driving pulley without requiring any alteration in the design of the bench. As a rule, but little variation is required from the standard motor pulley size. These draw-benches are designed so that they may be assembled either right-hand or left-hand, as desired, without requiring any change in castings or any special machine work. Another useful feature is that the bed is so constructed that it may be lengthened



Waterbury-Farrel Chain-driven Draw-bench for Tubing and Solid Stock

out at any time to suit the requirements of special work. Sight-feed oil cups are provided on all bearings in the driving mechanism, and the cut teeth of the drive and main sprockets do away with the majority of the noise incident to operating machines of this type. A steel channel is provided underneath the bed for supporting the chain instead of allowing it to drag on the floor. In addition to the three sizes of machines previously referred to, four small sized machines are built which have pulling capacities of 1000, 2000, 3500 and 6000 pounds, respectively; two larger machines are also built, which have pulling capacities of 40,000 and 60,000 pounds. These six machines provide for handling the same class of work as the three standard machines, but their capacities make them particularly well suited for exceptionally large or small work.

BEMIS WORK-HOLDING HEAD

Edgar W. Bemis, 92 West St., Worcester, Mass., is the manufacturer of a work-holding head for use on the milling machine, lathe or drill press. This head consists of a frame in which a hollow spindle is mounted. Inside the hollow

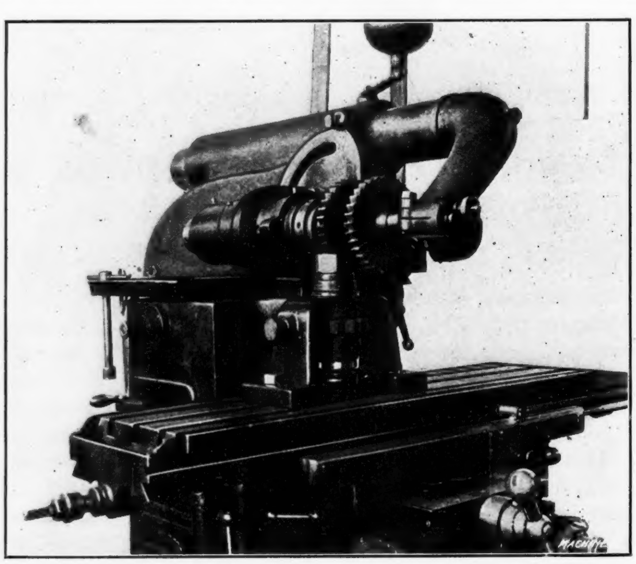


Fig. 1. Bemis Auxiliary Head set up on the Milling Machine

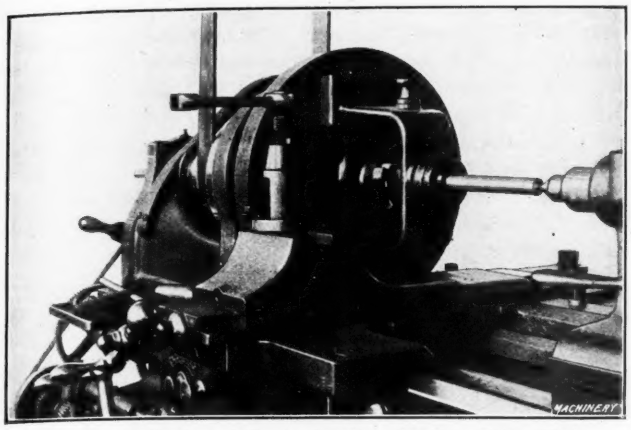


Fig. 2. Application of Bemis Auxiliary Head to Lathe Work

spindle there is a sliding spindle in which different sized collets can be mounted. At the opposite end from the collet, the sliding spindle is threaded into a handwheel which provides for drawing in the collet to grip the work. An index wheel is keyed to the outer or so-called hollow spindle. This index wheel has notches cut in its periphery which provide for indexing angles of 45 and 60 degrees, a spring plunger

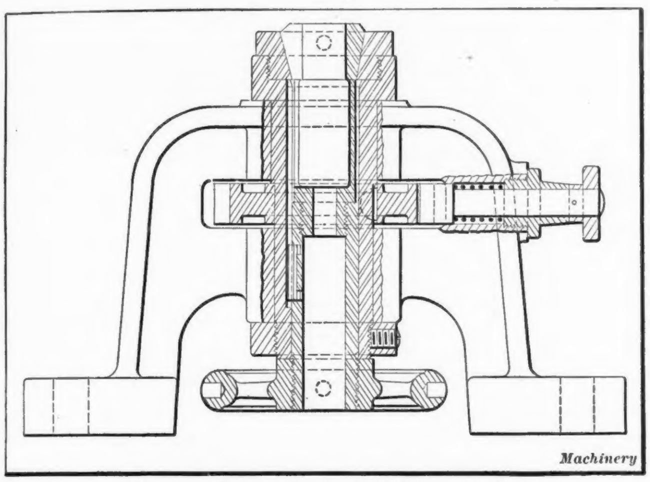


Fig. 3. Type A Bemis Work-holding Head

fitting into the required notch to locate and hold the spindle and work in the required position.

This head is made in two different styles which are known as the Type A and Type B heads. The Type A head, which is illustrated in Fig. 3, is equipped with a draw-in collet of standard design for holding pieces from 1/64 to 7/8 inch in diameter. Type B head is provided with a plug adapter on which threaded pieces can be mounted. These heads can be used on a milling machine for use in straddle milling such work as nuts of all kinds, and for various classes of tool-room and model work. The head is shown in Fig. 1 set up for milling a hexagonal nut. Fig. 2 shows the application of this head to the faceplate of a lathe, where the work is held by a draw-in collet. A typical application of the head for lathe work consists of cutting a multiple thread. After the first thread has been cut, it is required to index the work through 180 degrees (in the case of a double thread) ready for starting the next thread, and this can be easily done with the work held in this type of head. A particularly convenient feature is that after a piece has been put in the chuck, the head can be transferred back and forth between the lathe, drill press and milling machine for performing successive operations, without any serious loss of time in resetting the work, which would otherwise result in making such change.

VOLCANO NO. 3-C HAND TORCH

The Volcano Torch & Mfg. Co., Erie, Pa., is now making a No. 3-C hand torch which has an unusually high heating capacity for an equipment of this type. Instead of depending upon an air pump for generating the pressure, an auxiliary burner has been applied for this purpose, which heats the gasoline in the containing cylinder to give a pressure of from 125 to 250 pounds per square inch. In addition to the increased pressure secured in this way, the necessity for maintaining the required pressure by pumping at frequent intervals is avoided.

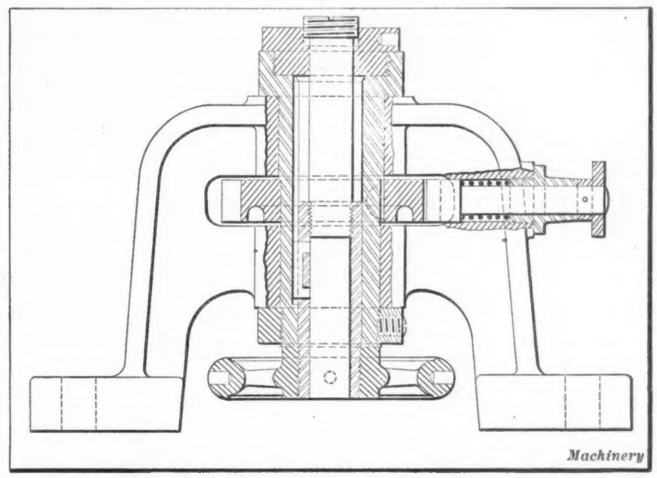


Fig. 4. Type B Bemis Work-holding Head

Referring to the illustration of the torch Fig. 1, the throttle or main valve which feeds the nozzle is controlled by the handle seen at the extreme right. The smaller handle below and to the left, is used for controlling the auxiliary burner which develops the pressure in the cylinder. This auxiliary burner is located inside the outer cylinder below the perforated section. A gaging device, seen on the right-hand side of the cylinder in Fig. 2, provides for regulating the amount of gasoline delivered to the auxiliary burner for use in pre-heating the gasoline in the main reservoir to generate the required pressure. A relief valve is provided for reducing the pressure when required, and there is also a safety valve to guard against the pressure being raised beyond a safe limit. Fig. 2 shows the pressure gage which enables the workman to see at a glance just what pressure has been developed in the cylinder.

One of the features of this torch is that it is unnecessary to stop the heating operation when it is required to replenish

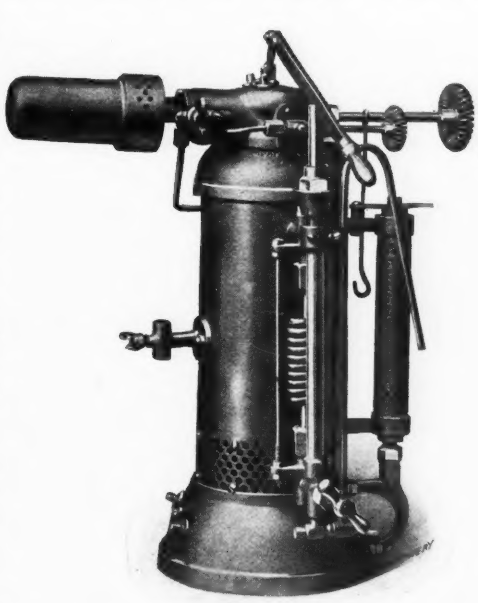


Fig. 1. Front View of Volcano No. 3-C Hand Torch

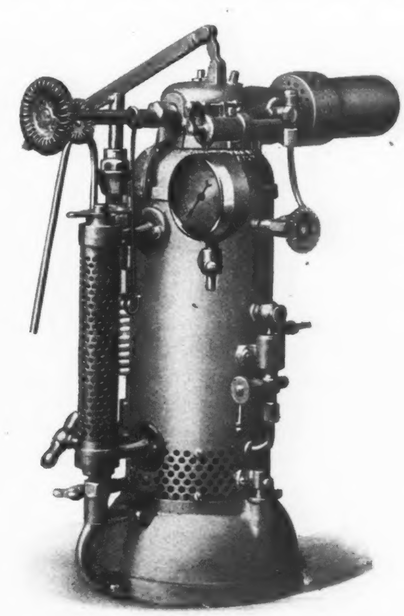


Fig. 2. Opposite Side of Torch shown in Fig. 1

the supply of gasoline in the main reservoir. It will be seen that there is a horizontal lever pivoted at the top of the torch and this lever operates a pump secured to the side of the torch. The small bent tube extending from this pump is provided for making connection with the supply of gasoline from which the required amount is pumped into the reservoir. The shut-off for the gasoline pump will be seen at the bottom of the pump in Fig. 1. The nozzle can be set in any required direction by means of an adjustment and then locked by a wing nut. An idea of the heating capacity of this torch may be gathered from the fact that a 9-inch solid round shaft can be heated red-hot for a distance of 12 to 16 inches in 30 minutes or to a brazing temperature in 1 hour 15 minutes, assuming that the heat is properly confined. This does not represent the maximum capacity of the torch, however, as larger work can be heated with it. The torch can be used out-of-doors in any kind of weather, and it will work with equal satisfaction in any position.

HEALD MAGNETIC CHUCKS

In the October, 1913, number of MACHINERY, rotary and planer types of magnetic chucks made by the Worcester Magnetic Chuck Co., were illustrated and described. This business has recently been taken over by the Heald Machine Co., 20 New Bond St., Worcester, Mass., and a number of noteworthy improvements have been made in the design and construction. In addition to incorporating refinements which make the chucks more efficient, new sizes and types have been brought out to cover a wider range of work. Two sizes of rotary chucks are illustrated in Fig. 1; the chuck shown at the left-hand side of this illustration is the 8-inch size, while the one to the right is a 12-inch chuck. The Heald Machine Co. is also making rectangular or planer type

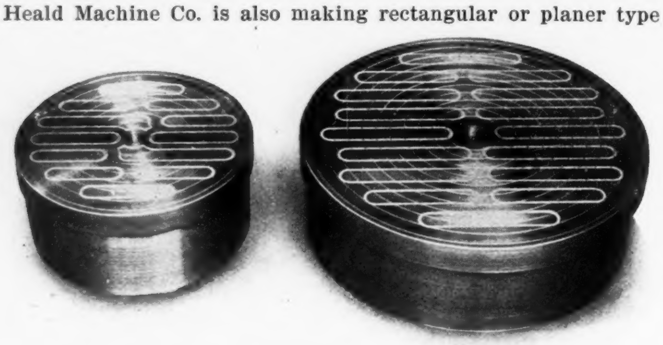


Fig. 1. 8- and 12-inch Sizes of Heald Rotary Magnetic Chuck

chucks as shown in Fig. 2, which are particularly designed for use on planers, milling machines, surface grinders and similar tools.

The most important feature of these new chucks is their great holding power, which exceeds one hundred pounds per square inch. The holding power is also very uniform over the face of the chuck, the claim being made that the variation does not exceed 5 per cent over the entire faceplate. The design is so worked out that the body of the chuck is free from magnetism, and this is a point of considerable importance as it eliminates the tendency to magnetize the machine on which the chuck is used. The poles are closely spaced with very little dead surface between them; and this enables a great range of work to be handled. Small and large pieces are held with equal efficiency. The chucks are water-proof and non-heating, all the coils being carefully proportioned and thoroughly protected from dampness. The faceplate is of unusual thickness which gives long life and provides for frequent truing. It is an easy matter to replace the faceplate, however, when it is worn out. The unit coil system is adopted, which makes each coil independent of other coils in the chuck, so that the failure of one or more coils does not put the entire chuck out of commission.

A cross-sectional view of the rotary type of chuck is shown in Fig. 3, from which the construction will be readily understood. Referring to this illustration, it will be seen that the chuck is composed of a steel body *A* to which the faceplate *B* which carries the pole pieces is attached. The body has projections *C* cast integral with it which receive the coils *D* and carry the magnetism to the pole pieces *E* in the faceplate of the chuck. The coils slip over the projections and the top faces of these projections are finished even with the sides or walls of the chuck body. The pole pieces, one of which is indicated at *E*, are insulated from the remainder of the faceplate by means of non-magnetic metal, this insulation being shown at *F*. The faceplate casting is also insulated from the main body of the chuck by means of a ring of non-magnetic metal *G* which prevents the magnetism from passing into the body of the chuck.

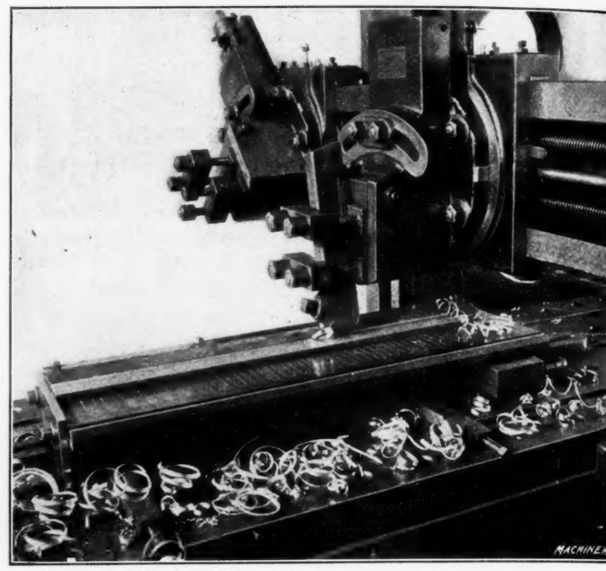


Fig. 2. Rectangular or Planer Type of Magnetic Chuck

In the rotary type of chuck, the current is delivered to a set of brushes which contact with two rings *H* and *I* of conducting metal, which are attached to the lower side of the chuck body. These rings are insulated from the body of the chuck by non-magnetic rings. A consideration of this cross-sectional view will show that the coils and wiring are readily accessible by simply removing the faceplate of the chuck. This plate is held in position by fillister head screws that pass up through the body and enter the under side of the plate. This construction eliminates difficulty arising from grinding away the heads of the screws, which results when these heads are placed in the faceplate of the chuck. The construction will be better understood by referring to Fig. 4 which shows the under side of the chuck with the fillister head screws in place.

A rotary chuck is shown in Fig. 5 with the top plate removed so that the inside of the chuck and the unit system of coils are plainly visible. The individual coils used for different sizes of Heald magnetic chucks have been stand-

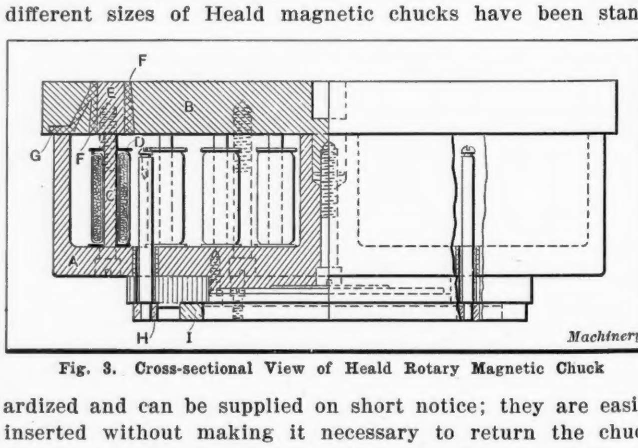


Fig. 3. Cross-sectional View of Heald Rotary Magnetic Chuck

ardized and can be supplied on short notice; they are easily inserted without making it necessary to return the chuck to the factory for repairs. After winding, the coils are carefully taped and thoroughly impregnated so that they will resist water and operate satisfactorily under temperatures as high as 500 degrees F. The insulation is so thoroughly protected that it is claimed the coils will operate when immersed in water.

It has already been stated that the holding power of these chucks is uniform within 5 per cent at all points on the faceplate. This uniformity has been determined by the use

of two one-inch steel cubes, one of which is placed near the center of the chuck and the other close to the periphery, a 16-inch chuck being used for the purpose. Two spring balances were then used to determine the holding power of the chuck, the balances being secured to rings on the upper side of the steel cubes. It was found that the holding power was the same at both places on the face of the chuck, and that the intensity was 112 pounds per square inch. This was by no means a record, however, as many of the chucks tested have shown a holding power as high as 125 pounds per square inch. It is claimed that this high power is due to the unit system of coils that is employed, and to the fact

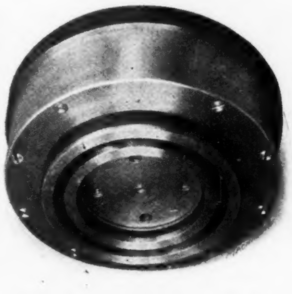


Fig. 4. Rear View of Chuck showing Method of securing Faceplate from Back

Fig. 5. Chuck with Faceplate removed to show Arrangement of Windings

that the chucks are made of steel instead of cast iron. As the current is delivered direct to each coil in the chuck, it works at maximum efficiency.

Another important feature which was briefly referred to in a preceding paragraph, is that the body of the chuck is entirely free from magnetism. This result is secured by the perfect insulation of the body from the faceplate of the chuck. Referring to the cross-sectional view shown in Fig. 3, it will be seen that a ring of non-magnetic metal *G* is placed between the top of the chuck body and the faceplate, which effectually prevents the magnetization of the body of the chuck and the machine on which it is mounted. This

Fig. 6. Application of Heald Chuck for Scraping Operations

does away with the annoyance frequently caused by having particles of metal adhere to the body of the chuck and to the machine, due to their magnetic attraction.

One of the strong objections to magnetic chucks has been due to the fact that, as they were not perfectly insulated, the electric current passed down into the machine itself and resulted in the operator frequently receiving a shock. The Heald chuck is carefully insulated so that this source of annoyance is avoided. Freedom from residual magnetism is another feature. Upon shutting off the current from the chuck, it is almost entirely demagnetized, making it easy to remove the work from the faceplate of the chuck without requiring the use of a demagnetizing switch for this purpose. This result is obtained by perfect insulation as well as the use of carefully selected material for each member.

The arrangement of the poles in these chucks makes it possible to hold all classes of work from small washers up to pieces of sufficient size to cover the entire faceplate of the chuck. The arrangement of the poles is such that there is very little "dead" surface on the faceplate, so that when used for grinding small washers or other comparatively small parts, there is no need of using special devices for locating the pieces on the chuck. It is only necessary to cover the chuck with the washers and they will all be held securely in place. The water-proof feature is obtained by having all joints so tight that it is practically impossible for water to find its way into the windings. In fact, there is only one chance for water to get through, which is at the edge of the faceplate, and that chance has been made practically nil through having the joint ground to a very close fit. Even if moisture should get into the chuck, the coils are so thoroughly taped that they are practically water-proof.

These chucks may be used on either 110 or 220 volt current. Alternating current cannot be used, and in plants where only alternating current is available, a small generator may be installed to furnish the required current. An idea of the current consumption may be gathered from the fact that a 1/4 horsepower generator will supply sufficient current to run

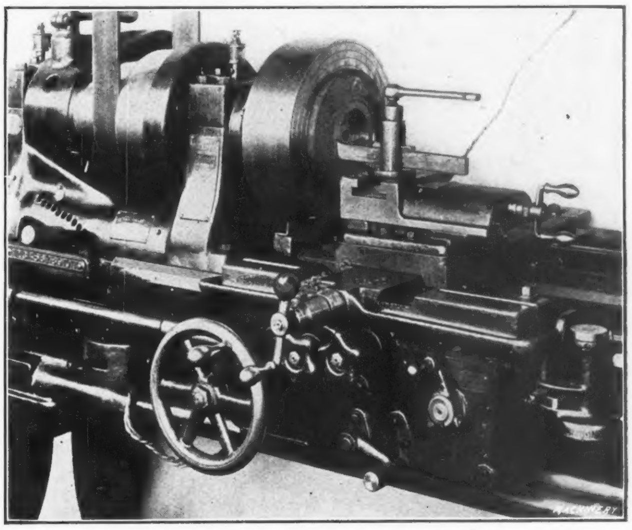


Fig. 7. Rotary Chuck set up on a Lathe

six of the 8-inch rotary chucks. An idea of the current required for different sizes of chucks may be gathered from the fact that a 12-inch rotary chuck requires only 0.6 ampere of current and the 8-inch rotary chuck requires 0.4 ampere. The 10 by 32-inch rectangular chuck takes 1.2 ampere.

The convenience of operation of the Heald magnetic chuck has led to its use in other classes of work than those for which it was originally designed. A typical example is shown in Fig. 6 which illustrates a 10 by 22-inch chuck which is being used as a scraping stand. The chuck is demagnetized for the removal of the work and the method is said to be far superior to that of holding the piece on a scraping stand. Fig. 7 shows a chuck mounted on a lathe and holding a cast-iron flange without the use of a center stud or side blocks. A facing cut 3/32 inch deep is being taken with a feed of 0.027 inch per revolution. The most striking application of the use of these magnetic chucks is illustrated in Fig. 2, which shows the chuck set up on a planer. A strip of machine steel is being held while a cut 5/16 inch deep is being taken with a feed of 5/32 inch. The cutting speed is 60 feet per minute and there is no tendency for the work to lift or move. The only support which the work received, aside from the holding power of the chuck, was from the guide strips at the end and on one side of the chuck. The same chuck was used on a milling machine for holding a cast-iron plate on which a 4-inch end milling cutter was fed to a depth of 5/16 inch, at a feed of 6 7/8 inches per minute.

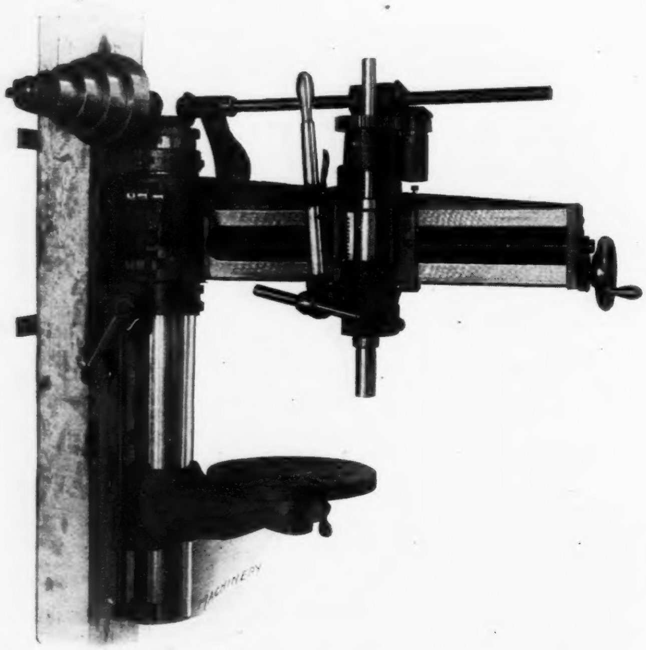
CANEDY-OTTO RADIAL DRILL

To meet the requirements of shops where a radial drill is needed, but where the price of a standard equipment of this type is prohibitive, the Canedy-Otto Mfg. Co., Chicago

Heights, Ill., has brought out the post type radial drill which is illustrated herewith. This is a powerful and accurate machine which is particularly adapted for use in machine shops, garages, blacksmith shops and bridge and boiler shops, where a wide range of drilling is done.

The drive is from a countershaft equipped with a four-step cone pulley and self-oiling bearings. This countershaft is customarily attached to the ceiling. The arm can be swung against the wall and it may be securely tightened in any position. The spindle head is traversed along the arm by means of a screw and handwheel. When the head has been brought to the desired position, means are provided for clamping it in place. The spindle has quick return by means of a hand lever, in addition to the regular hand feed which is provided by an independent lever.

The principal dimensions of the machine are as follows: Height, 56 inches; capacity for drilling to the center of a



Canedy-Otto Post Type Radial Drill

circle outside of the column 64 inches in diameter; maximum distance from center of spindle to column, 32 inches; minimum distance from center of spindle to the column, 7 inches; maximum distance from spindle to table, 18 inches; traverse of spindle, 9 inches; capacity for drills up to 1¼ inch in diameter; and net weight of machine, 800 pounds.

UNION TWIST DRILL CO.'S GROUND HOBS

For several years makers of gear cutting hobs have been trying to manufacture one-piece ground hobs, that is, those on which the sides and tops of the teeth are ground accurately to shape. Only by grinding hob teeth all over is it possible to eliminate all the changes of shape developing in the hardening operation. The Union Twist Drill Co., Athol, Mass., succeeded in solving the problem commercially some time ago and is now prepared to furnish hobs with all faces accurately ground to shape.

The ordinary commercial hob is ground only in the bore except, of course, grinding on the faces of the teeth in the gashes, to sharpen them. The grinding of the bore, however, does not take care of any of the errors due to hardening except the distortion of the hole. At best, it merely averages the total errors, of which there are four classes, namely: changes of lead, distortion of individual teeth, varying distance between gashes, and distortion of the hob to an out-of-round shape. The Union Twist Drill Co. states that the shortcomings of the unground commercial hob cannot be fully realized until the corrections made by the all-over grinding process are observed.

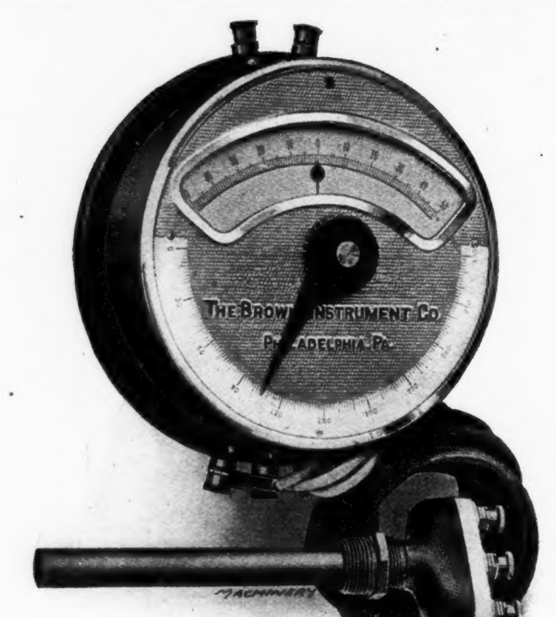
The advantages of the ground hob are not simply producing more nearly perfect gear teeth in the hobbed gears. The hob can be set up in the hobbing machine without reference to any particular tooth. When using unground hobs, it has been found necessary to center by some particular tooth in order to get the best results, but with the ground hob, the gears produced are equally good no matter what part of the hob is used for centering when setting up. Also, it is possible to use the end section of the hob and when this has become worn, the hob is moved along successively until all the teeth are dulled, when, of course, grinding the faces of the teeth to sharpen them is necessary.

To get the best results from ground hobs it is necessary that the gear cutting machine be in the best possible condition; in fact, it is more essential than ever that the machine be accurately adjusted and in perfect order. If end play in the spindle is present, or if the arbors are not true, the advantages of the ground hob will not be realized to the fullest possible extent. The superiority of ground hobs will not be so apparent on the general run of gear work as on the highest grade automobile gears and other constructions requiring smooth and noiseless action. The Union Twist Drill Co. furnishes the ground hobs at prices from 25 to 40 per cent higher than for the ordinary type of unground hob, the operation of grinding the sides of the teeth being a long and tedious one. At the present, the finest ground hobs that can be furnished are twelve diametral pitch.

BROWN RESISTANCE THERMOMETER

The Brown Instrument Co., Philadelphia, Pa., has recently brought out a new resistance thermometer for measuring temperatures from 200 degrees below zero to 1800 degrees Fahrenheit. This instrument is capable of great accuracy and is particularly adapted for measuring low temperatures which cannot be readily determined with the thermo-electric pyrometer. It is particularly suitable for determining the temperatures of driers and ovens, of the bearings of machines which may overheat, of the windings of motors and transformers, of refrigerating machines, and of furnaces used for the heat-treatment of steel where the temperature comes within the range of the instrument.

This thermometer consists of a bulb or coil of wire, the resistance of which changes with a change of temperature; and bulbs of this type can be located on various equipments



Brown Resistance Thermometer for Temperatures from — 200 to + 1800 Degrees F.

in a plant, where information concerning the temperature of such equipments is desired. A three-wire cable connects these bulbs with the indicating instrument and switchboard which can be placed in any desired position. To determine the temperature, it is simply necessary to switch the proper bulb onto the indicating instrument. If a constant temperature is to be maintained, the pointer of the indicating instrument can be adjusted to the required temperature and

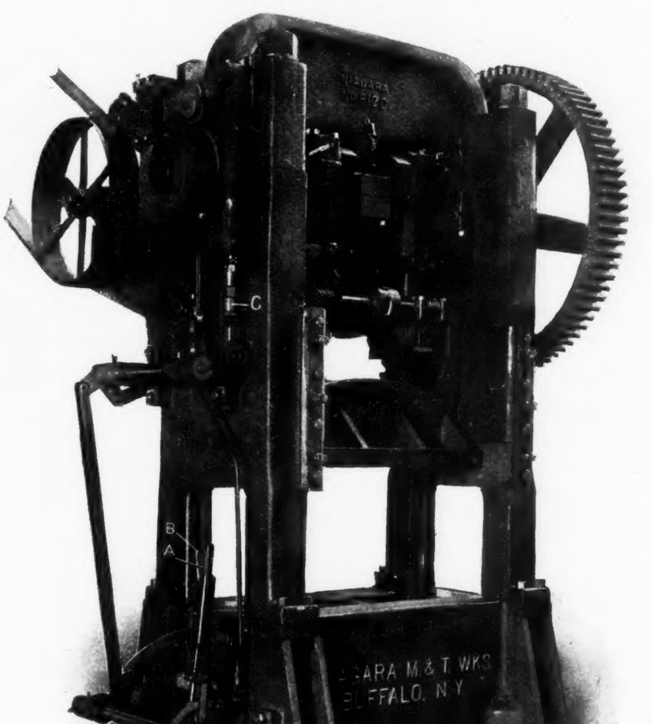
the deflection of the pointer on the upper scale of the instrument will show the increase or decrease in temperature from the required point. This new thermometer operates on either dry cells or storage batteries, or it may be connected with 110 or 220 direct current lighting circuits.

The chief advantages of the resistance thermometer are its suitability for use in determining moderate temperatures from one central location, eliminating the necessity of going about from one point to another to read the temperature as indicated by individual thermometers. As the bulbs used in connection with the new Brown thermometer are made entirely of metal, they are not likely to be broken. The indications of the instrument are guaranteed to be within 1 per cent of accurate.

NIAGARA DOUBLE CRANK PRESS

The accompanying illustration shows a large double crank press built by the Niagara Machine & Tool Works, Buffalo, N. Y. This machine is equipped with a device for controlling the clutch and the motion of the slide, which permits of engaging or disengaging the friction clutch at any time during the downward motion of the slide. The slide may also be automatically stopped at its highest position by this device, instead of by the treadle-actuated clutch that causes the crankshaft to make a complete revolution. The clutch is "non-repeating," as the controlling lever returns automatically to the starting point and is locked in position after the slide reaches its highest point.

In order to engage the clutch, the operator grasps the lever *A* and at the same time disengages locking lever *B*. The lever *A* is then pulled forward to the outer end of the segment and thus engages the clutch. The locking lever *B*



Niagara Double Crank Press equipped with Device for controlling Motion of the Slide

controls the action of a plunger engaging the connecting-rod *C*; *i. e.*, when the lever *B* is disengaged the connecting-rod *C* is also released, and the clutch lever *A* is free to be moved forward to engage the clutch. The return motion of the clutch lever is accomplished by means of a cam fastened to the outer end of the crankshaft. This improved feature can be applied to other presses equipped with a friction clutch. The present machine has the usual convenient features of adjustment that are found on all large Niagara presses. The driving mechanism is arranged overhead, thus making the machine accessible from all sides.

WALSH POWER PRESS SAFEGUARD

Among the various principles which have been applied in the design of safeguards to protect the operators of power presses from injury, one of the most successful is that in which the operator is required to use both of his hands in tripping the press. This principle has been applied to various forms of safeguards, one of the most recent of which is that manufactured by the Walsh Press & Die Co., 4709-4715 W. Kinzie St., Chicago, Ill. A Walsh inclinable press equipped with one of these guards is illustrated herewith. Referring to this illustration, it will be seen that there are two push buttons at the front of the die bed, and in order to trip the press, the attendant is required to push both of these buttons. The buttons are operated as easily as the keys of

Power Press Safeguard that requires the Operator to use both Hands to trip the Press

a typewriter, and they are placed at such a distance apart that it is impossible for both buttons to be pressed with one hand. In this way, it is impossible for a careless workman to have his hands on the die when the ram descends. The latch is automatically returned after each stroke of the press, so that it is impossible for the operator to only release the treadle enough to have it just draw the clutch bolt sufficiently to engage the edge of the latch—a practice which has been responsible for nine-tenths of the accidents where the claim has been made that the press "repeated." The entire mechanism can be locked back by means of a special key when the press is operated on ribbon stock. It is also possible to lock one of the two finger buttons, thus leaving one of the operator's hands free for feeding the press.

* * *

The effects of persistent advertising were never more forcibly felt than in the case of instructing workmen in the "safety first" movement. By the use of bulletins, lectures, printed warnings on pay envelopes and actual exhibitions, the need of caution on the part of the working-man is being emphasized. That it is having its effect is noticeable from the report of accident companies and industrial records.

NEW MACHINERY AND TOOLS NOTES

Draw-over Tool: J. Morrison Gilmour, 90 West St., New York City. A tool which takes the place of the hammer and chisel for drawing over holes which have run out at the starting point in drilling.

Portable Shear: The Canton Foundry & Machine Co., Canton, Ohio. A shear which is motor-driven and entirely self-contained; it is mounted on a truck so that it can be moved around the shop to any required position.

Gear Guards: Consolidated Expanded Metal Companies, New York City. Gear guards made of expanded mesh, which are known as the "steelcrete" mesh guards. They are made of cold-drawn mesh fabricated from basic open-hearth steel.

Surface Gage: W. P. Kirk, 336 W. 4th St., Cincinnati, Ohio. A surface gage of simple design which is particularly adapted for rapid manipulation. This gage is suitable for use on a wide range of work where accurate dimensions are required on interchangeable parts.

Hydraulic Press: E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. A hydraulic press built for drawing steel barrels in the plant of the Hydraulic Pressed Steel Co., Cleveland, Ohio. This is said to be one of the largest equipments of this type which has ever been built.

Axle Turning Lathe: Niles-Bement-Pond Co., 111 Broadway, New York City. A lathe designed for use in railway shops for turning and truing axles. The machine may be used for turning axles before the wheels are pressed in place and also for truing the journals after they have become worn.

Portable Arbor Press: Brickell Mfg. Co., Boston, Mass. A portable arbor press designed for pushing pulleys off shafts and for similar operations. As the pressure is applied directly to the member to be removed—close to the point where it hugs the shaft—an unusually high efficiency is secured.

Planers: Cincinnati Planer Co., Cincinnati, Ohio. A line of light planers built in 24-, 26-, 28- and 30-inch sizes. The notable features of the design of these machines consist of an extremely simple belt-shifting mechanism and a bed constructed in such a way that all of the gears are completely enclosed.

Gap Lathe: Summitt Machine Works, Worcester, Mass. A 10-20 inch gap bed engine lathe. The machine is also built with a plain bed. The carriage is arranged for the use of a taper attachment which can be applied at any time. The swing is 7½ inches and the weight of the machine with a 4-foot bed is 550 pounds.

Self-lubricating Bushings: The Graphite Metallizing Corp., Yonkers, N. Y. Bushings made of a product known as "graphalloy." This consists of graphite impregnated with molten metal, and it is said that the material makes excellent bushings for use on light duty machines, these bushings being self lubricated.

Slotter: Newton Machine Tool Works, Inc., Philadelphia, Pa. A crank slotter in which the speed-gear change mechanism is located in the head. The cutter bar carries a relief tool apron with vertical and horizontal clamping faces. The face of the bar is serrated to relieve the adjusting screw from strain when the tool is under cut.

Shaper Feed Mechanism: John Steptoe Co., Cincinnati, Ohio. An improved feed mechanism applied to the line of shapers built by this company. The mechanism is so designed that it may be employed as either a vertical or a cross feed. Previous machines built by this company have been equipped with only power cross feed.

Universal Woodworking Machine: Crescent Machine Co., 56 Main St., Leetonia, Ohio. A machine consisting of five units which comprise a band saw, a saw table, a jointer, a shaper and a boring machine. All of these are so mounted that any of them can be used independently, and the machines which are not in use do not have to be driven.

Engraving Machine: Alfred H. Schütte, Cedar and West Sts., New York City. A precision engraving machine which operates on the pantograph principle. The pantograph has four arms, three of which are adjustable by means of scales furnished with the machine. By means of these adjustable arms, it is possible to obtain any reduction between the limits of 1 to 1 and 10 to 1.

Fuel Oil Burner: Bellevue Furnace Co., Detroit, Mich. A burner designed to operate on a low pressure of air which is the means of greatly reducing the tendency toward scaling. The oil control is effected by means of a regular needle valve. The air controller consists of a central tube which carries the oil through the jet nozzle where it is mixed with the air and thus atomized.

Milling Machine: Gooley & Edlund, 581 S. Clinton St., Syracuse, N. Y. A manufacturing milling machine which is styled a Type-B Briggs miller. The distance between the housings is 17 inches; the working surface of the table, 54 by 11 inches; the traverse, 34 inches; and the maximum distance from the table to the center of the arbor, 15 inches. The weight of the machine is 4500 pounds.

Circular Saw Guard: L. F. Grammes & Sons, Allentown, Pa. A guard consisting of a number of shields suspended from a horizontal bar which, in turn, is supported by a rod connected to the ceiling. The bar from which the shields are suspended is supported in such a way that it will not vibrate. As the work is advanced to the saw, the shields are raised to provide the necessary clearance.

Conversion Chart for Money Values: S. C. Carpenter Drafting & Engineering Co., Hartford, Conn. In the March, 1914, number of MACHINERY, the Nos. 1, 2, 3 and 4 conversion charts made by this company were described. Since that time a No. 10 chart has been brought out which affords an easy method of converting the value of various foreign moneys into the equivalent in United States money.

Roll Grinding Machine: A. Garrison Foundry Co., Pittsburg, Pa. This company has recently redesigned the machine of its manufacture used for grinding chilled rolls. The special feature of the new machine consists of a mechanism for grinding tapered rolls. The capacity is for rolls up to 32 inches in diameter with necks which are not more than 9 inches smaller than the body of the roll.

Air Compressors: Clayton Air Compressor Works, 115 Broadway, New York City. Three types of air compressors which are particularly adapted for use in industrial plants requiring small amounts of compressed air. One of these is a portable motor-driven unit. The other two units are also motor-driven, one being a two-stage compressor and the other an automatic outfit designed to operate either continuously or intermittently.

Horizontal Milling Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. A duplex horizontal milling machine which has a table 20 inches in width. The table has positive geared feed and reversing fast power traverse. The spindles are driven by solid bronze worm-wheels and hardened steel worms. The spindle saddles are counterweighted and provided with hand vertical adjustment. The minimum distance between the spindles is 3 inches and the maximum distance 28 inches.

* * *

SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The spring or semi-annual meeting of the American Society of Mechanical Engineers was held in St. Paul and Minneapolis, Minn., June 16-19. Several of the papers presented dealt with the great engineering developments of the Northwest, with moving pictures showing ore handling on the Great Lakes. Opportunity was afforded the members to visit the milling district of Minneapolis, with its daily output of 84,000 barrels of flour, and to see the water power developments of the Mississippi River. Three professional sessions were held at which the following papers were presented:

"Pulverized Coal Burning in the Cement Industry," by R. C. Carpenter.

"Pulverized Coal for Steam Making," by F. R. Low.

"Industrial Service Work in Engineering Schools," by J. W. Roe.

"Classification and Heating Values of American Coal," by William Kent.

"The Railroad Track Scale," by W. W. Boyd.

"Gear Testing Machine," by Wilfred Lewis.

"The Flow Metering Appliance," by A. M. Levin.

"Power Development of the High Dam between Minneapolis and St. Paul," by Adolph F. Meyer.

"The Handling of Coal at the Head of the Great Lakes," by G. H. Hutchinson.

"Minneapolis Flour Milling," by Charles A. Lang.

* * *

A Curtiss aeroplane driven by two 100-H.P. eight cylinder motors is being built at Hammondsport, N. Y., to cross the Atlantic. Lieut. John C. Porte proposes to make the trip starting from St. Johns, Newfoundland, and landing at the Azores to rest and replenish the supply of gasoline. Thence he will go to Vigo, Spain, and thence to Plymouth, England. The estimated distance from St. Johns to the Azores is 1199 miles; from the Azores to Vigo, 963 miles; and from Vigo to Plymouth, 523 miles, making a total of 2685 miles. The estimated speed is sixty miles an hour and the total elapsed time for the flight is to be fifty-five hours, which gives an allowance of ten hours at the stopping places for replenishing fuel and resting.

BAR STOCK GUARD FOR TURRET LATHES

BY S. H. EARL*

The accompanying illustrations show a bar stock guard for turret lathes which has recently been installed in the Gleason Works, Rochester, N. Y. Referring to these illustrations it will be seen that the portion of the bar extending out from the spindle of the machine is completely enclosed so that it is impossible for the operator or those working in the vicinity of the machine to be injured.

The pipe which surrounds the stock is about one inch larger in diameter than the hole through the spindle of the machine. This pipe is mounted on brackets which are permanently fitted to the stock support standards at a sufficient distance below the stock support crotches to allow the

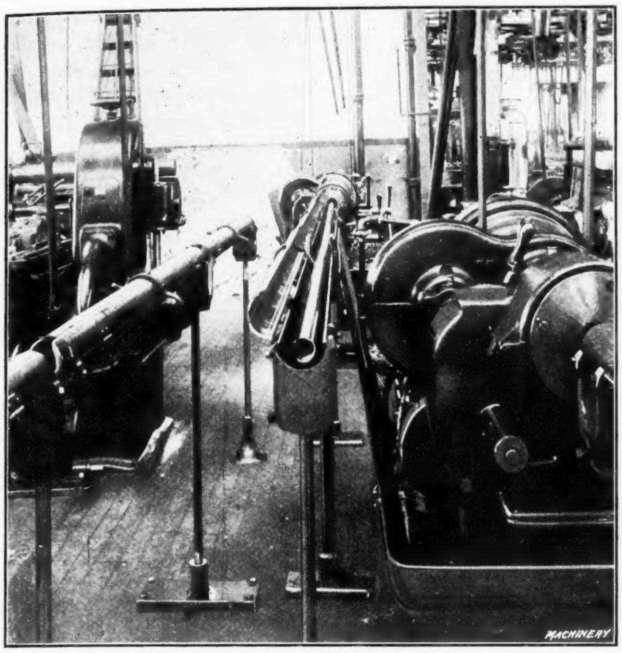


Fig. 1. Bar Stock Guard for Turret Lathes with the Pipe Open

crotches to be adjusted for various sizes of stock without adjusting the pipe. It will thus be evident that the stock is supported by the standard crotches provided with the machine and not by the pipe, which is merely employed to cover the stock to provide for the safety of employes. The pipe is split and the two halves hinged together, so that the guard may be easily opened to provide access in handling short bars. Fig. 1 shows the guard with the pipe open and in Fig. 2 the guard is shown closed ready for operation. Fig. 3

* Address: Gleason Works, Rochester, N. Y.

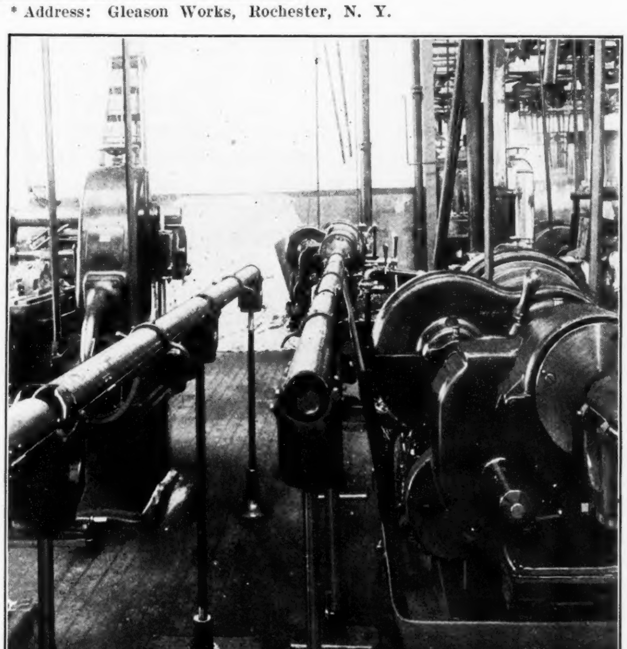


Fig. 2. Guard shown in Fig. 1 with the Pipe closed

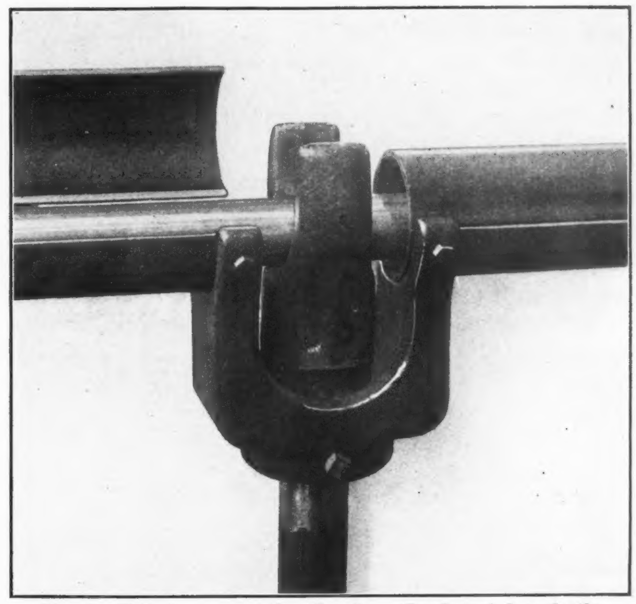


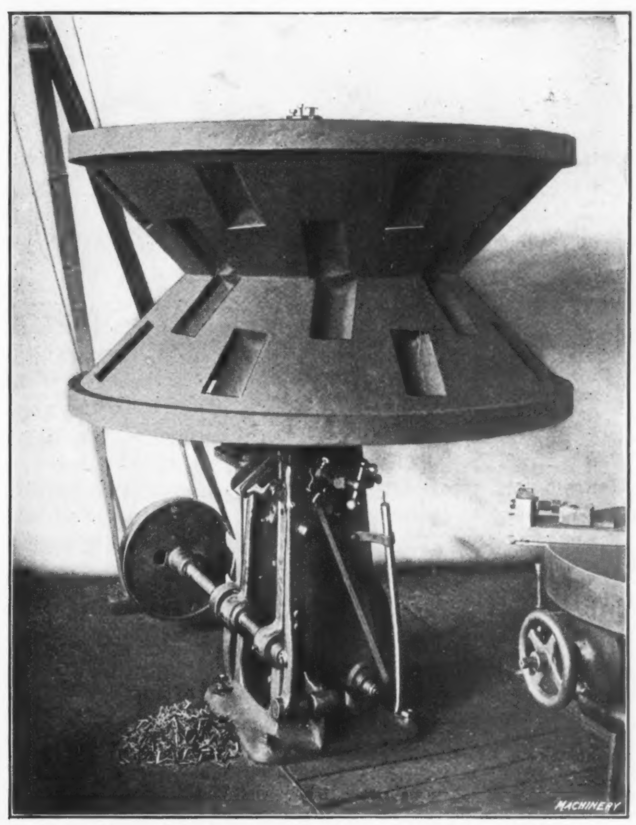
Fig. 3. Method of supporting Guard on Brackets independently of Stock Crotch

shows one of the supporting brackets in detail, together with the way in which the stock support crotch may be adjusted independently of the guard.

* * *

AN UNUSUAL KEYSEATING OPERATION

A No. 3A keyseating machine of 25-inch stroke, built by Mitts & Merrill, 843 Water St., Saginaw, Mich., is shown in the accompanying illustration, working on a decidedly unusual job. The work is a cylinder for an edging grinder which is used for grinding up refuse in saw mills. The capacity of this machine is 20 cords of wood per hour. The bore in the cylinder is 7 inches in diameter by 28 inches long, with a hub on each end which is 12 inches long. It is required to cut two keyways for tapered keys in this bore, the keyways being located 90 degrees apart; and they are 1½ inch wide by 1 1/16 inch deep at the deep end. The deep end of one keyseat is at one end of the bore and the deep end of the other keyseat is located at the opposite end of the bore. This keyseating operation was performed without re-



Unusual Keyseating Operation on a Mitts & Merrill No. 3A Keyseater

quiring the cylinder to be reversed. As the combined length of the keyseats is longer than the stroke of the machine, the cutter and feed wedge had to be shifted. The keyways were cut in one hub at a time. Despite the conditions under which it was necessary to do the work it was found that the keyways were as accurately aligned as though they had been machined by a continuous cut.

* * *

GUARDS FOR GEARS AND DRIVING BELTS

In view of the stringent legislation enacted by various states in regard to the guarding of gears and belts in manufacturing shops, this subject has become of general interest.

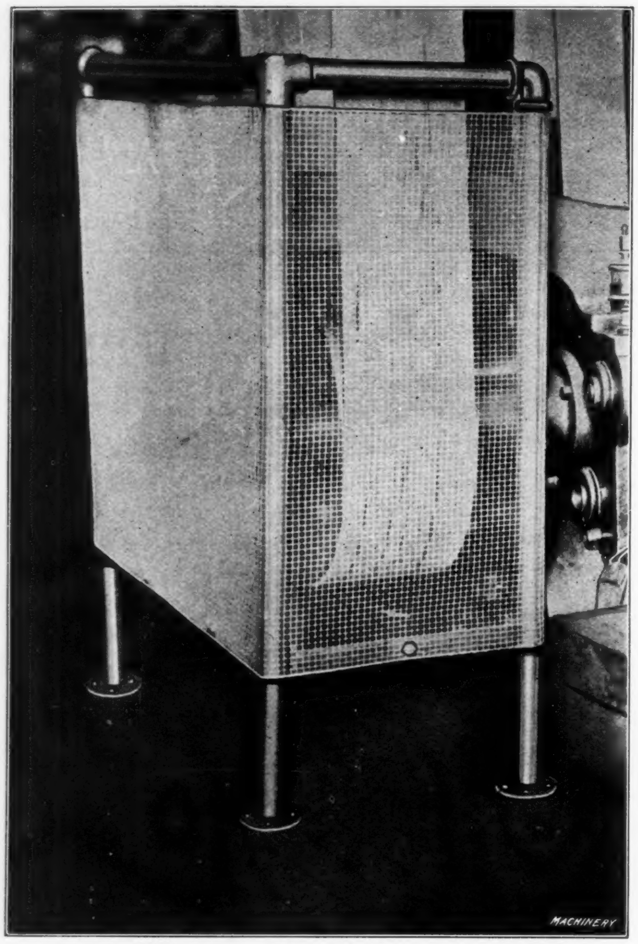


Fig. 1. Efficient Type of Guard for Gears or Driving Belts

An efficient belt guard is used in the shop of the Hays Mfg. Co., Erie. Pa. The illustration Fig. 1 gives a general idea of the way this guard is installed to protect a driving belt. The guard is composed of piping with the wire screening wrapped around. The most interesting feature, however, is the method by which the guard may be removed for shifting the belt, oiling or repairs. This is shown in the line illustration Fig. 2. The three uprights, composed of pipes, are not made fast to the floor, but are slipped over

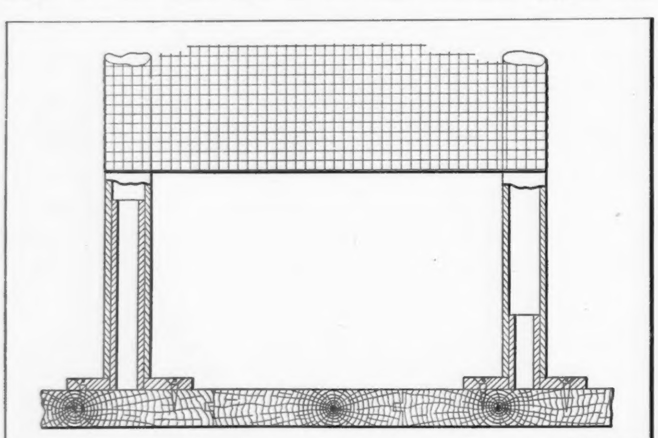


Fig. 2. Showing Removable Feature of Guard

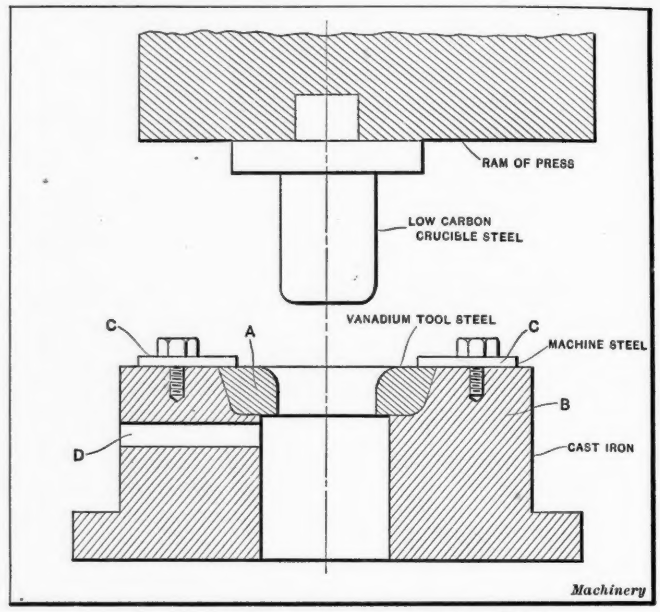
short lengths of flanged pipes that are screwed into the floor in the correct locations. One of the flanged pipes is about six inches in height. The others are short sections of approximately three inches, as shown at the right of the illustration Fig. 2. To remove the guard for oiling, it is simply necessary, therefore, to lift it three inches to clear the short lengths of flanged pipe, and swing it around on the pivot of the longer section at the outer corner. If necessary the guard may be raised entirely from connection with the flanged part. Guards of this type are cheap and strong, yet at the same time they are effective.

C. L. L.

* * *

MOUNTING DRAWING DIE RINGS IN CAST-IRON SHOES

In the March number of *American Vanadium Facts*, the mounting of a die ring in a cast-iron shoe, a practice of the Acklin Stamping Co., Toledo, Ohio, was illustrated and described. The ring, which was made from a special brand of "Ceswic" vanadium tool steel, was turned to the form shown in the accompanying illustration and tapered 1½ degree on the sides. This die ring was used for blanking a cup from ¼-inch sheet steel, and produced 10,000 of these cups without any indication of wear. To draw up a cup of the following



Mounting Light Die Rings in a Cast-iron Shoe

dimensions—3½ inches in diameter by 1¼ inch deep—from ¼-inch stock requires that the die be rigidly supported.

Referring to the illustration it will be seen that the vanadium tool steel die ring *A* is held in a cast-iron shoe *B* by heavy steel plates *C*. In some cases these plates take the form of a continuous ring instead of individual plates. The three holes *D*, only one of which is shown, are utilized in operating dogs that remove the cup from the punch. The machine steel plates *C* also act as a gage for locating the blank when drawing. The taper on the edge of the die, which is shown greatly exaggerated in the illustration, is not over 1½ degree, and it has two advantages: First, it enables a close contact between the supporting cast-iron shoe and the light steel die ring to be secured. The outside of the die ring is ground so that it will be perfectly true with the hole, and to such dimensions that when it is dropped into place in the die shoe it will stand up about 1/64 inch above the top surface, resting only on the tapered sides. Pressure is then applied to force it down to the bottom, seating it in the die shoe; this puts a strain on the cast iron and insures the desired contact between the shoe and ring.

Another reason for the taper is that after the die ring has been in use for some time and it is necessary to redress it, it is much easier to chuck the ring up for machining than it would be to chuck up both the ring and shoe together, and the slight taper on the sides allows the ring to be easily driven out, whereas if the hole were straight and the die ring wedged in with the same pressure, considerable difficulty

would be experienced in removing it. For drawing heavy sheet metal ¼ inch thick, very little, if any, float of the die is necessary, so this forms a very satisfactory means of holding the die ring. It also increases its life considerably, as the cast-iron shoe takes all the strain.

The heat-treatment given to drawing dies made from "Ceswic" special vanadium tool steel is as follows: The steel, which generally comes in flat disks 6½ inches in diameter by 1¼ inch thick, is annealed before it leaves the mill. After being machined the dies are heated to a temperature of about 1450 to 1500 degrees F. in a muffle furnace and are then quenched in cold water, a current of water being forced down to the center hole. The object in thus directing the water is to harden the surface of the hole, leaving the balance of the die ring comparatively soft and as tough as possible. The die blanks are then drawn to a light straw color, just enough to remove the hardening strain. The life of a die made from this brand of steel was found to be over twice as long as that of one made from any other steel that the Acklin Stamping Co. tested for this job.

* * *

A NEW ARC WELDING MACHINE

A wide field has been opened up to electric arc welding within the last few years. For boiler repairs in particular, this form of welding has been extensively adopted. There are three different systems of arc welding, the oldest of which is the Bernardos. In this system a carbon electrode is connected to one pole of a source of supply, the article to be welded being connected to the other. In this manner an arc can be formed between the carbon and the work which corresponds to the flame in autogenous welding. The workman manipulates the carbon rod similarly to an autogenous welding burner; he has the advantage of only having to use one hand, however. As soon as he touches the work with the carbon electrode, current passes; when he removes the electrode a few millimeters a welding arc is formed which causes the surface of the work to melt on account of its heat. If fresh metal has to be added, a bar of metal is held in the arc, where it reaches a molten condition and drops onto the part to be welded. In place of the Bernardos process that of Slavianoff is frequently employed. In this latter process, in place of the carbon electrode, a metal rod similar in composition to the article to be welded is employed. This rod melts gradually.

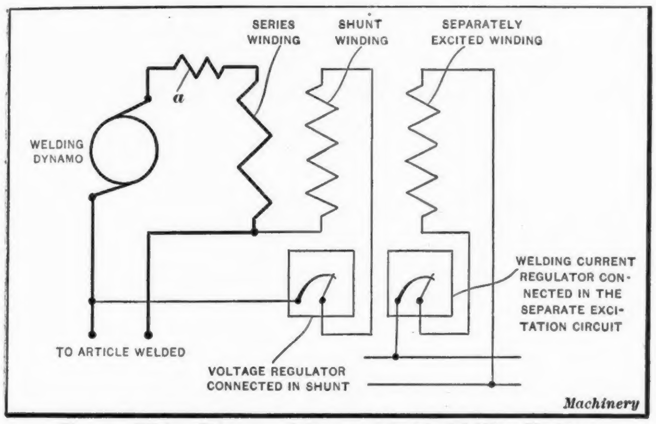


Fig. 1. Wiring Diagram of Kramer Electric Welding Machine

The third welding process is Zerener's. By this method, two carbon electrodes are fixed in a suspended armature at an angle to each other. The arc formed between them is blown against the article to be welded by an electro-magnet. Both carbon rods are connected through the armature and brought over the work together, thus forming a substitute for an electric welding burner. Direct current is used in all three processes. The arc requires pressures from 45 to 65 volts. The special properties of the arc welding process make it necessary to employ special dynamos for generating the welding current. It is impossible to avoid the constant lengthening of the arc, and therefore the alteration of its resistance while welding. When the electrodes touch, for example, a short circuit is set up, and on moving them backward and forward the length of the arc can be varied within wide limits. In consequence of the considerable changes of resistance thus brought about the current can only be taken from a direct-current network or shunt generator after special series resistances have been connected in circuit, which occasions a great loss of energy.

The Allgemeine Elektricitäts-Gesellschaft, Berlin, Germany, developed methods some time ago for utilizing the welding energy without losses. Further progress has now been made in this direction by the use of a welding dynamo connected in accordance with the Krämer patent. This machine generates energy at the required voltage directly, and always supplies current of the same strength, notwithstanding considerable resistance fluctuations in the welding circuit. At the same time a perfectly steady arc is obtained. The heat flowing to the article welded is therefore quite constant, a matter of cardinal importance for satisfactory welding. The peculiar property of the new Krämer welding dynamo of giving a constant current with a variable resistance is obtained by means of a three-fold field excitation, as may be seen from the diagram of connections in Fig. 1, reproduced from *The Mechanical Engineer*. One field winding is a differentially connected series winding, the second is a shunt, and the third a separately excited winding which receives current from a special network with a constant voltage. Any given welding current most suitable for the work can be obtained by adjusting the regulator for the separate excitation. The voltage of the machine may be altered by the regulator for the shunt excitation. Thus a finely graduated adjustment of the current and voltage may be obtained by suitably arranging the two regulating resistances, so that the machine can be adapted within wide limits to the requirements for the welding work in hand. Fig. 2 illustrates the value of the current for a Krämer machine adjusted for a welding current of 150 amperes. It clearly shows that the welding current remains constant even when the arc resistance varies from zero (*i. e.*, short circuit) to 0.5 ohm. Only after attaining a still higher resistance does the current begin to fall gradually.

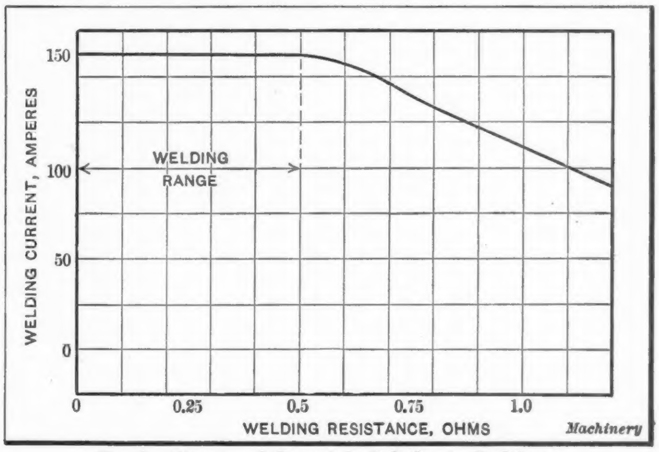


Fig. 2. Diagram of Current in Relation to Resistance

* * *

PERSONALS

Augustus Teuchter, of the Cincinnati Bickford Tool Co., Cincinnati, Ohio, sailed June 16 for a European trip.

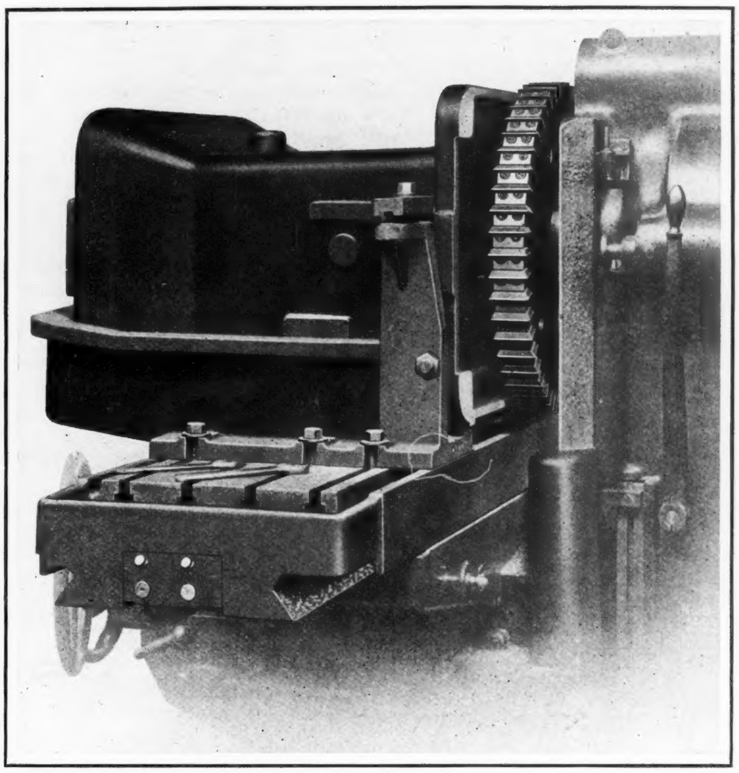
James O. Smith, formerly domestic sales manager of the American Emery Wheel Works, Providence, R. I., has been elected vice-president.

Erik Oberg, associate editor of MACHINERY, sailed with his wife and son, May 13, for a two months' trip to England, France, Germany, Denmark, Sweden and Belgium.

Henry Dreses of the Dreses Machine Tool Co., Cincinnati, Ohio, builder of drilling machines, sailed June 16 on the *Kronprinzessin Cecilie* for a three months' business trip in Europe.

H. P. Fairfield, instructor in shop engineering with the Worcester Polytechnic Institute, Worcester, Mass., has been promoted to an assistant professorship of machine construction.

R. S. Alter, secretary of the American Tool Works Co., Cincinnati, Ohio, left on Saturday, June 13, for a combined business and pleasure trip through Great Britain and the Continent.

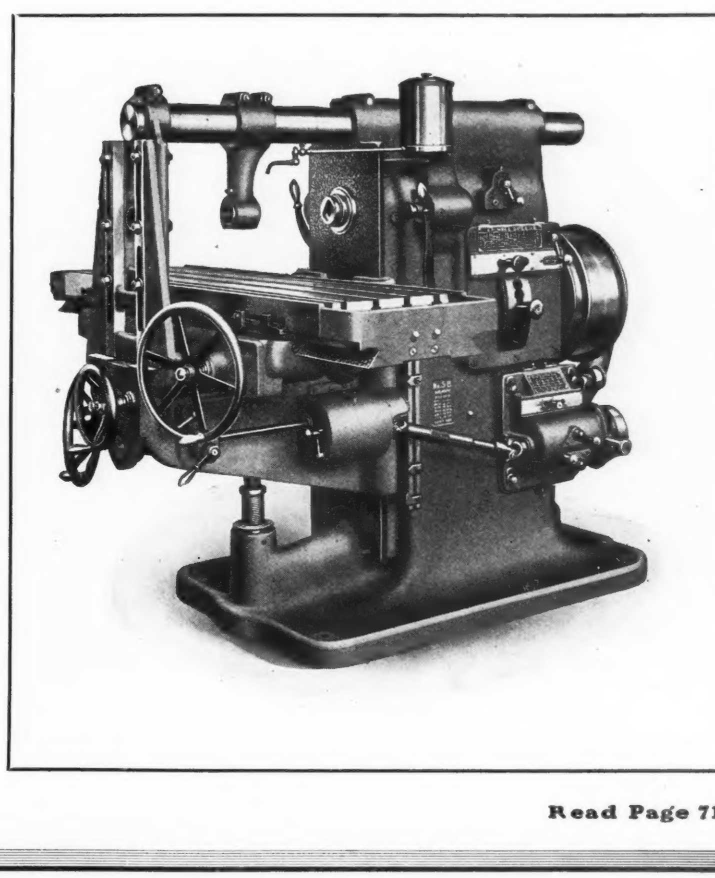


Unusual stiffness in our table, saddle and knee prevents springing under heavy loads.

Done on a Heavy Service Machine

A 1000 Pound Job
The casting is 25″ high from the table, and extends 35″ out from the cutter. A 26″ inserted tooth face milling cutter is used. In addition to indicating rigidity of design, this job shows how the milling machine will economically handle a class of work often done on a planer.

A Machine for Such Work
All three jobs were done on the No. 5-B Heavy Plain Milling Machine. Surely milling machines which have consistently produced accurate results on jobs like these have proved themselves *Heavy Service* machines. This is only one of our extensive line, all designed for rapid and accurate production. May we send interesting literature?



MFG. COMPANY
RHODE ISLAND

Read Page 71

Elmer E. Metzger recently resigned the position of works manager with the Esterline Co., Indianapolis, Ind., and has been appointed works manager by the Geometric Tool Co., New Haven, Conn.

M. J. O'Neill, general manager of the Industrial Press, sailed with his family, June 25, for a two months' trip in Europe, visiting England, Holland, Belgium, Germany, Switzerland and France.

Dr. Robert Grimshaw of Dresden, Germany, a well-known contributor to technical journals and a former resident of the United States, was married to Miss Marta Scharfstein at the home of the bride, Schleswig-Holstein, May 15.

R. Poliakoff, assistant professor and lecturer in mechanical technology in the Imperial Technical Institute of Moscow, Russia, is visiting manufacturing plants in the United States to study their methods of manufacturing, management, etc. Prof. Poliakoff expects to be in the United States about ten weeks.

J. L. Bender, recently sales manager of the Grant-Lees Gear Co., Cleveland, Ohio, has taken charge of the sales department of the Yuster Axle Co. of Cleveland. Mr. Bender has been in the automobile field for years and has the benefit of long training in the organizations of two companies in the automobile axle field, the American Ball Bearing Co. and the Timken Roller Bearing Co.

William A. Bole has been elected by the directors of the Westinghouse Machine Co. vice-president in charge of production and erection for the plants at East Pittsburg and Trafford. Mr. Bole has been in the continuous employ of the company since August, 1882, having successively filled the positions as general shop foreman, superintendent, manager of works and consulting engineer. He has therefore taken part in the growth and development of the company since the time when it employed less than one hundred men until the present, when the total forces run up into the thousands.

Richard Ward Baker, for fifty years an employe of the Watson-Stillman Co. of Aldene, N. J., and New York City, was presented with a substantial check and a month's vacation in recognition of his long term of service. Mr. Baker began his apprenticeship in a small factory in Grand St. June 2, 1864, and has been continuously identified with the Watson-Stillman Co. and its predecessor ever since. The board of directors of the company passed a special resolution expressing its high esteem of Mr. Baker's long and loyal service, which was presented to him in the presence of the employes, officers and directors at its Aldene plant.

OBITUARY

Paul L. Heroult, who developed the electric furnace process of manufacturing aluminum in 1887-8, simultaneously with C. M. Hall in America, converting it from a laboratory curiosity into a common household article, died in Paris May 9, aged fifty-one years.

COMING EVENTS

July 15-22.—Second International Congress of Consulting Engineers, to be held in Berne, Switzerland.

September 5-11.—Foundry and machine exhibition, showing machinery, tools, equipment and supplies for the foundry and machine shop, Chicago, Ill. C. E. Hoyt, secretary, Foundry & Machine Exhibition Co., 1949 W. Madison St., Chicago, Ill.

September 15-18.—Twenty-second annual convention of the Traveling Engineers' Association at the Hotel Sherman, Chicago, Ill. W. O. Thompson, secretary, c/o New York Central Car Shops, East Buffalo, N. Y.

September 17-22.—Autumn meeting of the Iron and Steel Institute in Paris, France. Offices of secretary, 28 Victoria St., London, S. W., England.

September 20-25 (1915).—International Engineering Congress, San Francisco, Cal. In connection with the Panama-Pacific International Exposition. W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

SOCIETIES, SCHOOLS AND COLLEGES

University of the State of New York, Albany, N. Y. Bulletin 569 containing list of helpful publications concerning vocational instruction, prepared by Lewis A. Wilson, specialist in industrial schools. 41 pages, 6 by 9 inches. Published by the University of the State of New York, Albany, N. Y.

Williamson Free School of Mechanical Trades, Williamson School P. O., Delaware County, Pa. Bulletin 15 containing record of graduates. This bulletin gives a summary of replies sent in answer to a letter of inquiry addressed to 863 former students. The annual income of 664 graduates is a little over $1,000,000, or an average of $1512 yearly each.

NEW BOOKS AND PAMPHLETS

Mine Signboards. By Edwin Higgins and Edward Steidle. 13 pages, 6 by 9 inches. Illustrated. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical Paper 67.

Abstracts of Current Decisions on Mines and Mining. By J. W. Thompson. 140 pages, 6 by 9 inches. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin 79, Law Serial 2.

Problems of the Petroleum Industry. By Irving C. Allen. 20 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical Paper 72, Petroleum Technology 17.

Safety and Efficiency in Mine Tunneling. By David W. Brunton and John A. Davis. 271 pages, 6 by 9 inches. Illustrated. Published by the Bureau of Mines, Department of the Interior, Washington, D. C., as Bulletin 57.

Physical and Chemical Properties of the Petroleums of California. By Irving C. Allen, Walter A. Jacobs, A. S. Crossfield and R. R. Matthews. 38 pages, 6 by 9 inches. Published by the Department of the Interior, Bureau of Mines, Washington, D. C., as Technical Paper 74, Petroleum Technology 18.

Hydraulics. By Ernest H. Sprague. 184 pages, 4½ by 7¼ inches. 89 illustrations. Published by Scott, Greenwood & Son, London, England, and sold in the United States by D. Van Nostrand Co., 25 Park Place, New York City. Price $1.25 instead of $1, as quoted in the review notice which appeared in the May number.

Tests of Bond between Concrete and Steel. By Duff A. Abrams. 238 pages, 6 by 9 inches. 86 illustrations. Published by the Engineering Experiment Station, University of Illinois, Urbana, Ill., as Bulletin 71.

This bulletin furnishes one of the most exhaustive studies of the amount and distribution of the bond stress between concrete and steel that has been published. It records the results of tests of about 1500 pull-out specimens and 110 large reinforced concrete beams. The tests covered a wide range of ages, mixes, size of bar, length of embedment, condition of storage, method of supplying the load, etc. Both plain and deformed steel bars were used.

Official Report of the National Machine Tool Builders' Association. 161 pages, 6 by 9 inches. Illustrated. Published by the National Machine Tool Builders' Association, Charles E. Hildreth, general manager, Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

This report contains the proceedings of the semi-annual convention of the National Machine Tool Builders' Association, held at the Hotel Bancroft, Worcester, Mass., April 23-24. The papers presented were: "What Features of Electric Motors can be Standardized for Machine Tools," by Charles Fair of the General Electric Co., Schenectady, N. Y.; "How May We and Our Men Earn More Money," by J. C. Spence, superintendent, Norton Grinding Co., Worcester, Mass.; and "Safety as applied to Grinding Wheels," by R. G. Williams, safety engineer of the Norton Co., Worcester, Mass.

Modern Methods of Waterproofing. By Myron H. Lewis. 40 pages, 6 by 9 inches. Illustrated. Published by Norman W. Henley & Son, New York City. Price, 50 cents.

The efficiency and durability of ordinary concrete work are detrimentally affected in many instances by the fact that it is not waterproof. Permeable concrete is likely to be seriously damaged in winter by freezing and in many instances it is absolutely necessary that the seepage of water be prevented, especially in cellars and other places where goods are stored. The pamphlet which forms a chapter of the author's new book, "Popular Handbook for Cement and Concrete Users," treats of the necessity for waterproofing; method of conducting the work; methods of waterproofing, which are designated as three, these being the membrane, integral and surface coating method. The composition of some of the waterproofing compounds in use is given and an outline of the methods available for various structures. The approximate cost of waterproofing is included, a feature that will be generally appreciated by builders.

Fan Engineers' Handbook. Edited by Willis H. Carrier, chief engineer. 581 pages, 4¼ by 6⅝ inches. Illustrated. Bound in leather with rounded corners and gilt edges. Published by Buffalo Forge Co., Buffalo, N. Y. Price $3.

This work, containing tables, charts and data on the application of centrifugal fans and fan system apparatus, including engines and motors, air washers, hot blast heaters and systems of air distribution, is essentially a handbook for the heating and ventilating engineer. It is divided into five parts, the contents of which are as follows: Part 1, Properties of Air; Part 2, Applications—Heating, Ventilation, Air Washing, Cooling, Humidifying, Drying, Mechanical Draft, Exhaust Systems and Miscellaneous Applications; Part 3, Air Ducts; Part 4, Apparatus, Fans, Fan Testing, Fan Capacities, Fan Dimensions, Heaters, Air-conditioning Apparatus, Steam Engines, Practical Applications and the Selection of Apparatus for Heating and Ventilating; Part 5, Specifications, Miscellaneous Engineering Data. This valuable compilation of data edited by Mr. Carrier should be welcomed by engineers generally concerned with any of the problems incident to the movement of air.

Standard Gear Odontographs. By Warren E. Thompson. 37 pages, 8½ by 11 inches. Illustrated. Published by Warren E. Thompson, 42 Sayles St., Southbridge, Mass. Price $2.

The book is issued in a small edition, the illustrations and tables being blueprinted and the text "multigraphed." It describes the method of laying out 14½-degree and 20-degree pressure angle gears, giving odontograph tables for both which agree closely with the tables used by the principal manufacturers of so-called "involute" gear cutters. Contrary to the general impression, commercial form cutters do not produce true involute teeth; the curves are modified to eliminate the interferences that are developed in a set of interchangeable gears ranging from a 12-tooth pinion to the rack. The diagrams show exactly how to lay out the empirical curves, giving all the required data. A feature of the book that will be of great interest to all toolmakers is the description of making the forming tool. Probably the making of tools for forming gear cutters is the most highly developed toolmaking practice. The block templet system is described which enables the toolmaker to produce forming tools of any required circular or diametral pitch for a given number of teeth from one pattern.

NEW CATALOGUES AND CIRCULARS

Kales-Haskel Co., Detroit, Mich. Folder giving dimensions of card-holders and pipe and wire clips.

Link-Belt Co., Chicago, Ill. Book 195, 40 pages, 6 by 9 inches, treating of Link-Belt newspaper conveyors.

W. W. & C. F. Tucker, Hartford, Conn. Circulars of self-closing oil hole covers, styles D, E, F and G.

M. H. Fischer & Sons Co., Inc. 41 Park Row, New York City. Circular of Fischer's automatic press guard.

C. G. Garrigus Machine Co., Bristol, Conn. Circular of 12-inch rotary precision surface grinder with magnetic chuck.

Buckeye Engine Co., Salem, Ohio. Bulletin 111-B descriptive of the "Buckeye-mobile" engine for which a very low fuel consumption is claimed.

Chambersburg Engineering Co., Chambersburg, Pa. Calendar for June, 1914, to June, 1915, illustrating a Chambersburg 10-ton steam drop-hammer.

Sterling Grinding Wheel Co., Tiffin, Ohio. Circulars and price lists of "Seneca" hacksaw blades and "Sterling" and "Advanced Safety" grinding wheels.

Manufacturing Equipment & Engineering Co., Boston, Mass. Leaflets of sanitary bubbling fountain, sanitary washbowls and metal and fire-proof equipment for shop and office use.

Volcano Torch & Mfg. Co., Erie, Pa. Circular supplementing catalogue 17, describing "Volcano" torch No. 3-C. This torch generates its own pressure and no air pump is required.

Walworth Mfg. Co., maker of brass and iron valves and fittings, Boston, Mass., is issuing a monthly publication entitled "The Walworth Log" devoted to the interests of the company.

H. G. Smith & Co., Plantsville, Conn. Leaflet illustrating the "Gittatit" off-set combination slip joint plier, illustrating its use as a cotter-pin extractor, wire cutter and off-set handle wrench.

Pawling & Harnischfeger Co., Milwaukee, Wis. Bulletin 3018 on the applications of electric hoists, showing one- and two-ton hoist installations handling paper, bar iron, pipe, plates, boxes, machinery, etc.

Bury Compressor Co., Erie, Pa. Catalogue 44, 40 pages, 6 by 9 inches, on air and gas compressors and vacuum pumps. A number of installations of Bury air compressors in various plants are shown.

W. L. Brubaker & Bros., 50 Church St., New York City. Illustration and list of hexagon bolt

dies. This form of die is very convenient for use in close quarters in straightening bruised threads on studs and bolts.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin 34-C describing and giving specifications for Chicago Classes "H-SG" and "N-SO" pneumatic gasoline and fuel oil engine driven compressors.

Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa. Pamphlet on Hess-Bright ball bearings for axle lighting generators, comprising a brief discussion of ball bearings and their application to axle generators.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Catalogue 3002-A, Section 3049-A on electric arc welding processes, illustrated with examples of work done and describing Westinghouse electric arc welding outfits.

Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa. Sheets 99, Class IV and 100 Class V, dealing with ball bearing mountings for semi-floating rear hub and ball bearing mountings for jib crane columns, respectively.

Canedy-Otto Mfg. Co., Chicago Heights, Ill. Circular of wall or post radial drill No. 50, especially adapted for work in shops where a radial drill is necessary but too costly. It drills to center of circle 64 inches diameter, outside of column.

Standard Tool Co., Cleveland, Ohio. Folder descriptive of the "Standard" patent emery wheel dresser. The cutter is of hardened tool steel and of such construction that the cutting edges always retain the same sharp angle until worn to the hub.

Greenfield Machine Co., Greenfield, Mass. Circular of the Greenfield No. 1 plain grinding machine with hydraulic table feed. The advantages claimed for this feed are very smooth and even movement and unlimited number of speed changes from zero to the maximum.

Walsh Press & Die Co., 4709-4711 W. Kinzie St., Chicago, Ill. Circular of the Walsh safety device for power presses which makes it necessary for both of the operator's hands to be placed on finger buttons before the treadle can be tripped and the clutch of the machine released.

Gisholt Machine Co., Madison, Wis. Folder B. M. F.-1, descriptive of the Gisholt 42-inch boring mill, especially adapted for machining locomotive driving boxes. A special type of chuck is employed which allows this work to be done much more rapidly than by former methods.

Hannifin Mfg. Co., Chicago, Ill. Catalogue on "Aero" chucks, 38 pages, 4¾ by 7 inches, showing air-operated chucks of the universal, collet, alligator, releasing, and milling machine types. Air-operated countershafts, clamping fixtures, vises and special tools are also illustrated.

Dazie Mfg. & Supply Co., Inc., Lawrence & Clearfield Sts., Philadelphia, Pa. Circular of "Drive-Em-All" drill sockets, consisting of a rifled ferrule forced onto the shank of the drill which interlocks with the end of the regular Morse collet or socket, the same having been milled to fit.

Westmacott Gas Furnace Co., Providence, R. I. Sectional catalogue of Westmacott gas blast furnaces, showing bench furnaces, oven furnaces, muffle furnaces, melting furnaces, tinning and galvanizing furnaces, blast soldering iron heaters, brazing blow-pipes and positive pressure blowers.

Automatic Drill Chuck Corporation, Majestic Bldg., Detroit, Mich. Catalogue of "Quictite" automatic drill chuck operated by hand without keys or wrenches while spindle is running. The chuck grips straight shank drills, reamers or counterbores and holds more tightly as the load increases.

Lutz-Webster Engineering Co., Inc., Philadelphia, Pa. Circular of the Lutz compressed pipe and stud wrenches, lathe dogs and drill ratchets. The compression wrenches grip the smooth surfaces of pipe or studs without marring and drive positively, releasing on the back stroke and gripping again on the reverse.

Fort Wayne Electric Works of the General Electric Co., 1616 Broadway, Fort Wayne, Ind. Bulletin 46203 for March, 1914, illustrating and describing type K5 single-phase watthour meters. The advantages claimed for this meter are simplicity in mechanical construction, compactness, and a high degree of accuracy.

Ingersoll-Rand Co., 11 Broadway, New York City, is issuing a limited number of books containing a reprint of an article from "Scribner's" magazine on the Panama Canal. The book is handsomely illustrated with plates showing the dams and locks in natural color. The last two pages show Ingersoll-Rand drills used in excavating the canal.

Link-Belt Co., Chicago, Ill. New book No. 190, 31 pages, 6 by 9 inches, illustrating and describing the Link-Belt portable wagon and truck loader. This machine will load coal, coke, gravel, stone, sand and similar loose materials from ground storage at the rate of sixty tons an hour. It will load a five-ton auto truck in less than five minutes.

Sanitation Corporation, 50 Church St., New York City. Bulletin, Series G, No. 2 containing an article by Dr. Endris on the mechanical treatment of sewage in Germany and the application of the Reinsch-Wurl screen thereto. Managers of isolated manufacturing plants having to render their sewage innoxious will find this bulletin of interest.

Bonney Vise & Tool Works, Inc., Allentown, Pa. Catalogue 18, comprising 68 pages, 6 by 9 inches. This book was compiled with the idea of presenting not only a catalogue of Bonney products but a reference book on vises and wrenches as well. All the types of wrenches and vises (with the exception of pipe vises) in common use are illustrated.

Cincinnati Bickford Tool Co., Oakley, Cincinnati, Ohio. Circular R 3 A, descriptive of 4-, 5- and 6-foot regular plain radial drills equipped with variable speed motor drive and motor and speed box drive. The machines may, at extra cost, be fitted with a special base, cooling equipment, tapping hood, tapping lead mechanism and other special attachments.

Prince-Groff Co., 50 Church St., New York City. Circular of the "Kwik-grip" positive-lock vanadium steel pipe wrench. This wrench of the "alligator" type is made with the serrated jaw in line with the axis of the handle. This construction is claimed to effect an improvement in the gripping power and efficiency of the wrench as compared with the ordinary alligator type.

Jaeger Rotary Valve Motor Co., Inc., Mount Vernon, N. Y. Catalogue of the Jaeger rotary valve, six-cylinder 60-horsepower motor. The design of the motor eliminates poppet valves and camshafts, one valve serving for all cylinders, being located longitudinally in the tops of the cylinders. This valve is cooled internally and externally and it is driven by gearing from the crankshaft.

Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa. Catalogue on the application of Hess-Bright ball bearings in flour and feed milling machinery. It is claimed that these bearings when properly mounted and not overloaded, have practically no wear and should last as long as the machine. They require no refitting or other attention of any sort, save to supply lubricant once in two or three months.

Newton Machine Tool Works, Inc., Philadelphia, Pa. Catalogue 48 of horizontal milling machines of the planer type. Examples of the company's slotting machines; special grinding machines, including locomotive link grinding machines; cylinder and valve chamber boring machines; vertical milling machines; crank planing machines; locomotive rod boring machines; cold metal sawing machines are also shown.

Lufkin Rule Co., Saginaw, Mich. Catalogue 9, containing 110 pages, 6 by 9 inches. This catalogue is devoted exclusively to measuring tapes and rules. Attention is called to the fact that in addition to this line which the company has manufactured for the last twenty-five years, it now has ready for the market a complete line of folding boxwood, and flexible spring joint wood rules. Requests for copies of this catalogue will receive prompt attention.

Electric Controller & Mfg. Co., Cleveland, Ohio, is distributing a booklet which is a reprint of an article entitled "Lifting the One Hundred and Thirty Million Pound Quebec Bridge," by H. F. Stratton, that appeared in the December, 1913, issue of the "Engineering Magazine." With the exception of the motors, all the electrical apparatus used in erecting the Quebec Bridge is being designed and supplied by the Electric Controller & Mfg. Co.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue P, 35 pages, 6 by 9 inches, treating of "Brownhoist" overhead hand-traveling cranes. These cranes consist of a single I-beam supported at each end on a patented truck-frame of cast steel. The construction is such as to permit them to be used where there is very limited head-room. The tables of dimensions, prices, etc., will be found useful by those desiring to purchase this equipment.

Peter A. Frasse & Co., Inc., 417 Canal St., New York City. New catalogue on steel. 40 pages, 4¼ by 6½ inches. This book contains a complete description of high-speed tool steels, alloy tool steels, carbon tool steels, die-sinking steels, special tool steels, construction steels, spring steels, etc., made by this company. Some valuable tables on machining allowances, hardening colors and temperature equivalents, weights of bar steel per foot, etc., are included.

American Roller Bearing Co., Pittsburg, Pa. Catalogue entitled "Roller Bearings for All Purposes," 16 pages, 6 by 9¼ inches, dealing with the advantages, construction and application of the "American" roller bearing. These bearings are especially designed for conditions where the load is unusually severe. They are adapted for motor car construction, lineshaft hangers, loose pulleys, railroad service, trolley wheel equipment, and many other classes of service.

National Tube Co., Frick Bldg., Pittsburg, Pa. Proceedings at the annual meeting of the stock holders of the United States Steel Corporation, April 20, 1914, and statement as to wages, hours and other conditions of labor among employes of the United States Steel Corporation and subsidiary companies. Those interested in profit sharing plans and the relation of employes to one of the largest corporations in the world will find these reports of extraordinary interest.

Mesta Machine Co., Pittsburg, Pa. Bulletin on air compressors and vacuum pumps. The air compressors manufactured by this company have been equipped with an automatic plate valve (Iversen patent) which makes possible the economic use of much higher piston or rotative speed. The higher speed permissible means a smaller cost of installation, inasmuch as the compressor equipped with plate valves takes only about two-thirds of the floor space required by other compressors.

Pratt & Whitney Co., Hartford, Conn. Catalogue on the Pratt & Whitney side head boring mill, 34 pages, 9 by 12 inches. This catalogue is handsomely illustrated with a number of halftones showing the machine in its various working positions. The side head of the machine is operative on work up to 38 inches in diameter and the vertical head is operative on work 44 inches in diameter. The independent side head which may be lowered below the work table permits of increased swing.

Lumen Bearing Co., Buffalo, N. Y. Booklet on "Lesoyl," a semi-fluid concentrate containing graphite in suspension. "Lesoyl" is mixed with lubricating oil and grease to improve its lubricating quality; its virtue does not lie in the graphite alone, but in a large measure is due to the ingredients composing the menstruum in which the graphite was ground. While "Lesoyl" is used to improve lubrication on all bearing surfaces, it is especially valuable where the pressure on the bearings is severe and intermittent.

R. D. Nuttall Co., Pittsburg, Pa. "Heat-treatment of Gears and Pinions," a treatise prepared by W. L. Allen, commercial engineer, which is intended to give builders and users of machinery a better idea of the great improvement in the physical characteristics of steel to be obtained by heat-treatment. The company makes a specialty of heat-treating gears and pinions and the booklet is written with the view of informing the average man on some of the technical features of modern heat-treatment methods.

Vulcan Process Co., Inc., 25th and University Aves., S. E., Minneapolis, Minn. New book entitled "Vulcan Process Instructions on Oxyacetylene Welding and Cutting." 86 pages, 6¼ by 8¾ inches. Although pertaining especially to Vulcan apparatus, this book contains much general information on welding. It takes up the formation and composition of the oxyacetylene flame, its use and application, as well as the various equipment with which it is used. A number of interesting repairs made by the oxyacetylene process are shown.

Schuchardt & Schutte, Cedar and West Sts., New York City. Circular of gage standards adaptable in combinations of 0.00001 inch, the individual block units being of such precision that a combination of four or five of them will have a total error of not more than 0.00004 inch. These gage standards are made of high-carbon steel rectangular prism shapes with highly polished parallel surfaces, each block being stamped with its dimension. The standard gages are sold in various combinations and numbers. The circular also illustrates and describes a precision measuring and screw testing microscope which gives means of measuring the pitch, depth of thread and angle of screw threads.

Builders Iron Foundry, 9 Codding St., Providence, R. I. Bulletins Nos. 1 to 7 inclusive in "Builders Construction Series," entitled "The Better Grinder," illustrating methods of construction employed in manufacturing "Builders" grinding machines, as follows: 1, Machine-molding "Builders" Heads; 2, Grinding Grinders; 3, Grinding Spindles; 4, Milling Heads; 5, Inspecting Spindles; 6, Shrinking on Pulleys; 7, Assembling Smaller Sizes of Heads. These bulletins, 9 by 12 inches, are issued each month and each is illustrated. Mechanical men generally will find the series of interest and value as they illustrate and describe the methods followed in the manufacture of a well-known floor grinder.

National Machinery Co., Tiffin, Ohio. "National Forging Machine Talk No. 3" discusses the value of large "gather" in the forging machine. By "gather" is meant the distance of travel of the heading ram after the gripping dies close. Realizing the importance of this point in design, the National Machinery Co. makes its heavy-pattern forging machines with three different "gathers" as follows: 246 heavy-pattern forging machine, 2 inches rated capacity, 4 inches die opening, 6 inches gather; 357 heavy-pattern forging machine, 3 inches rated capacity, 5 inches die opening, 7 inches gather; 469 heavy-pattern forging machine, 4 inches rated capacity, 6 inches die opening, 9 inches gather.

Bristol Co., Waterbury, Conn. Bulletins 188 and 189 on two types of Bristol recording differential pressure gages. Bulletin 188 describes the patented spring type of Bristol recording differential pressure gage equipped with diaphragm or helical type pressure tubes and a patent frictionless sleeve. Bulletin 189 treats of the patent float type of Bristol recording differential pressure gage in which no springs are employed. This type is especially recommended, although there are certain applications for which the spring type is adapted. These gages are particularly valuable for use in connection with pitot tubes and venturi tubes for measuring and recording the rate of flow of air, gas, steam, water and other liquids.

General Electric Co., Schenectady, N. Y. Bulletin 41302 covers the complete line of G-E standard polyphase induction motors. The repair parts for this line are also illustrated. Bulletins 43400, 43401 and 43402 deal with the subject of modern lighting in woodworking plants, the clothing industry and machine shops and metal working plants, respectively. The various lamps adapted for this service are described and suggestions are given as to the size and style of the units best suited to secure the greatest efficiency. Bulletin 46201 takes up the construction of the single-phase watthour meter, type I-14. Bulletin 48010 is devoted to the use of electricity in the shoe and leather industry. Illustrations show numerous installations in various factories of prominence in the East.

Ingersoll-Rand Co., 11 Broadway, New York City. Bulletin Form 8011 describing the construction and operation of "Little David" riveting hammers. Illustrations show the application of these tools. All "Little David" riveting hammers can be furnished with a rivet set retainer as illustrated in Form 8011-I. This retainer is simple in design and meets the requirements of the safety laws being drafted by the various states. All those interested in "Safety First" as applied to the operation of pneumatic riveting hammers should have this booklet. Copies sent free on request. Form 4020 treats of Leynor-Ingersoll water drills. Among the unique features of construction may be mentioned the hand hammer blow, the water feature, the oiling system, the butterfly valve, etc. A descriptive table giving sizes and capacities of these drills is included.

TRADE NOTES

C. W. Leavitt & Co., 30 Church St., New York City, have been appointed American selling agents for carbonless metals and alloys made by the Iron & Steelworks Mark, Wengern-Ruhr, Germany.

Nutter & Barnes Co., Hinsdale, N. H., manufacturer of metal saw cutting-off machines, automatic saw sharpeners and abrasive wheel cutting-off machines, has opened a Chicago store at 13 S. Clinton St., where machines and samples will be on exhibition.

H. W. Johns-Manville Co., Madison Ave. and 41st St., New York City, has removed its Duluth office to larger quarters at 327 W. First St. The new office is on the ground floor and has a full display of J-M asbestos roofing, pipe coverings, packings, sanitary specialties, auto accessories, etc.

Strong, Carlisle & Hammond Co., Cleveland, Ohio, has been appointed exclusive distributor in Cleveland and surrounding territory of "Toledo" (Sheffield) high-speed and carbon tool steels made by Jno. Hy. Andrew & Co., Ltd., Sheffield, England. The company carries complete stocks of these steels in the Cleveland warehouse, 326 Frankfort Ave., N. W., England.

Covington Multiple Drill Co., Covington, Ky., manufacturer of multiple-spindle drill heads, has been incorporated. The incorporators are A. P. Kern, R. K. Le Blond and Philip C. Fosdick. A. P. Kern is president and Philip C. Fosdick, secretary and treasurer. The company will install considerable new machinery and equipment to take care of its rapidly increasing business.

Steinle Turret Machine Co., Madison, Wis., has made new arrangements for the sale of the Steinle turret lathe, the former selling connections with Manning, Maxwell & Moore, Inc., having been discontinued. Hill, Clarke & Co., 156 Oliver St., Boston, Mass., have been appointed exclusive agents in the New England states, and the Laughlin-Barney Machinery Co., Union Bank Bldg., Pittsburg, Pa., has been given the exclusive right of sale in Western Pennsylvania.

Excelsior Tool & Machine Co., East St. Louis, Mo., is building a new machine shop to adjoin the company's present plant. The addition will be completed within about ninety days and will necessitate the employment of thirty or forty additional men, which will increase the force to a total of 120 or 130. One of the largest purchasers from the Excelsior plant is the United States Government, 1,200,000 castings being shipped in 1912 from the plant to the Panama Canal.

Wells Bros. Co.'s and Wiley & Russell Mfg. Co.'s factories of the Greenfield Tap & Die Corporation, Greenfield, Mass., will close for their annual vacation July 3-20, in accordance with their usual custom of permitting the employes to take their vacations at the same time without interfering with business. The offices, however, will be open and all emergency orders for taps, dies, screw plates, etc., will be promptly attended to; large orders not in a rush will be filled after the vacation is over.

Sterling Grinding Wheel Co., Tiffin, Ohio, is installing new equipment of machinery and fixtures in its elastic wheel department. The company's business in this type of wheel has increased to such an extent that it is now devoting nearly the entire second floor of its north building having an area of about 5000 feet, to its manufacture. Several new ovens, presses, etc., will be installed as soon as possible. The manufacture of brass, bronze and aluminum castings has been added to the foundry department.

Dalton Adding Machine Co., Poplar Bluff, Mo., will move its plant employing about six hundred people to the Norwood district, Cincinnati, about July 1 where a factory has been secured that will permit of greatly increasing the facilities for manufacturing adding machines. The company expects to employ one thousand people in the near future. The machinery, tools, facilities, etc., will be moved in one solid freight train of about forty-eight cars and the employes will travel to Cincinnati in a passenger train of eighteen cars.

American Emery Wheel Works, Providence, R. I., recently increased its machine shop facilities by the addition of new machine tools; a 1000-ton hydraulic press, complete with pump, will be installed in the manufacturing department. Work will soon be started on the third-floor addition, 55 by 100 feet, to the company's East River St. building, which will be used for the main office. The present ground floor offices will be converted into additional manufacturing space, made necessary by the constantly increasing business.

Taft-Peirce Mfg. Co., Woonsocket, R. I., held a general sales conference of its various field representatives at the factory the latter part of the first week in June. Those present were: R. E. Carpenter, sales manager; C. O. Cromwell; C. S. Collinson of the Western district, headquarters in Detroit; A. H. Mitchel and E. R. Abbott of the New York district, headquarters in New York City; A. H. Hudson and H. B. Randall of the New England district, headquarters Woonsocket, R. I. The western and New York representatives were optimistic, holding that the outlook for business is good, especially through the Middle West.

Niles-Bement-Pond Co., 111 Broadway, New York City, was awarded a million dollar contract by the Chinese government for the equipment of a small arms arsenal at Hanyang near Hankow, China. The contract is for complete equipment, including machine tools, gages, fixtures, jigs, cutters, etc., all of which will be supplied by the Pratt & Whitney Co. plant, Hartford, Conn. The arm is of the Mauser type and equipment for manufacturing includes the rifle, bayonet, scabbard, stock and everything complete, comprising 105 parts. The output of the arsenal is to be one hundred guns a day and the labor cost per gun is to be not more than twenty-three man-hours.

Hydraulic Press Mfg. Co., Mount Gilead, Ohio, has enlarged its brass foundry in order to take care of the increased demand for "Mount Gilead" hydraulic valves and fittings. The foundry now occupies a building 90 feet long by 30 feet wide and three furnaces are continuously operated. The company has built a new erecting shop 120 feet long, 80 feet wide and 54 feet high for the erection of heavy hydraulic presses and pumps. Two accumulators, one for high pressure and one for low pressure, and an intensifier have been installed for the testing of all hydraulic presses, pumps, valves and fittings before they leave the factory. The testing equipment includes motor-driven high- and low-pressure pumps controlled by automatic electric starters, and has a maximum pressure capacity of 10,000 pounds per square inch.

Standard Welding Co., Cleveland, Ohio, reports that its business for the month of March, 1914, was the biggest in every way that the company has ever enjoyed. It totaled 25 per cent more than the month of March, 1913, and 5 per cent more than any previous month in the history of the organization. In the steel tubing department, which supplies a large part of the bicycle, motorcycle, automobile and kindred industries, the present output is over 2,000,000 feet a month. About a year ago, the company changed its merchandising policy. Previously it sold practically only to the manufacturers, but now it sells to the jobbing and retail trade. In the past year arrangements have been perfected with more than thirty of the largest jobbers on the continent whereby the company's rim product is now carried in all the large centers for distribution to dealers and car owners in those respective territories.

Niles-Bement-Pond Co., 111 Broadway, New York City, was awarded a prize of $20,000 by the Chilean Government for the best design of a railroad shop having capacity for from 500 to 600 locomotives, 500 passenger cars and 6000 freight cars. The Niles-Bement-Pond Co. treated the matter exhaustively and submitted plans embodying the latest practice of American railroading in every particular. Forty sheets of drawings were submitted, showing the ground plan and elevation of every building; also a plan of the yard with tracks, yard cranes, paving, etc., complete. Plans of the wiring, power distribution, and of a central power station and its equipment were included. Two complete plans of machine and erecting shop, one of the transverse pattern and one longitudinal, were submitted, showing the machine tools in groups, one group for each item of the locomotive. It is believed that the plans submitted were more complete in every particular than were ever prepared for a locomotive shop of this size before. The shops will cost approximately $3,000,000. The second prize was awarded to a combination Belgian and English concern.